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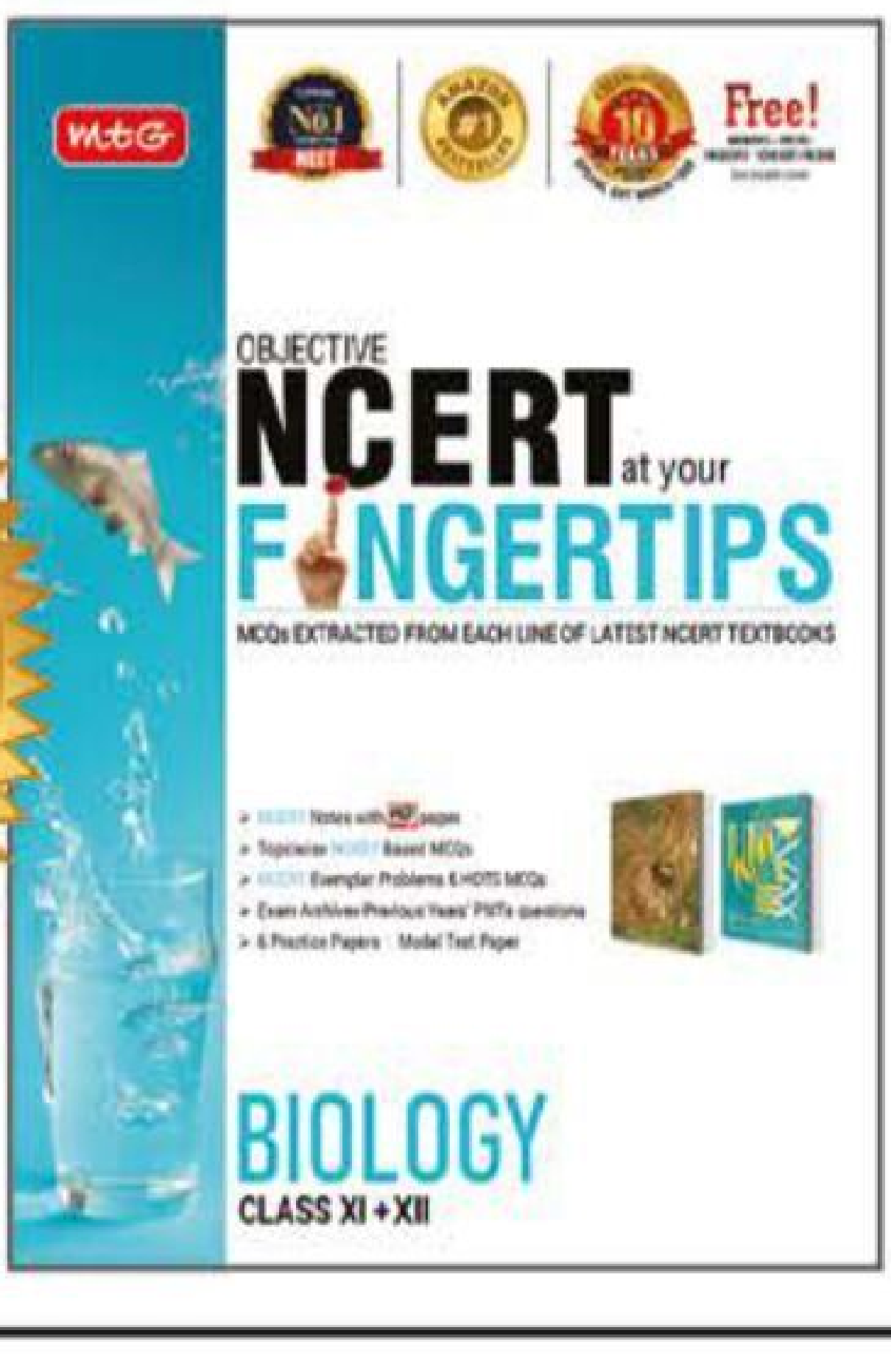
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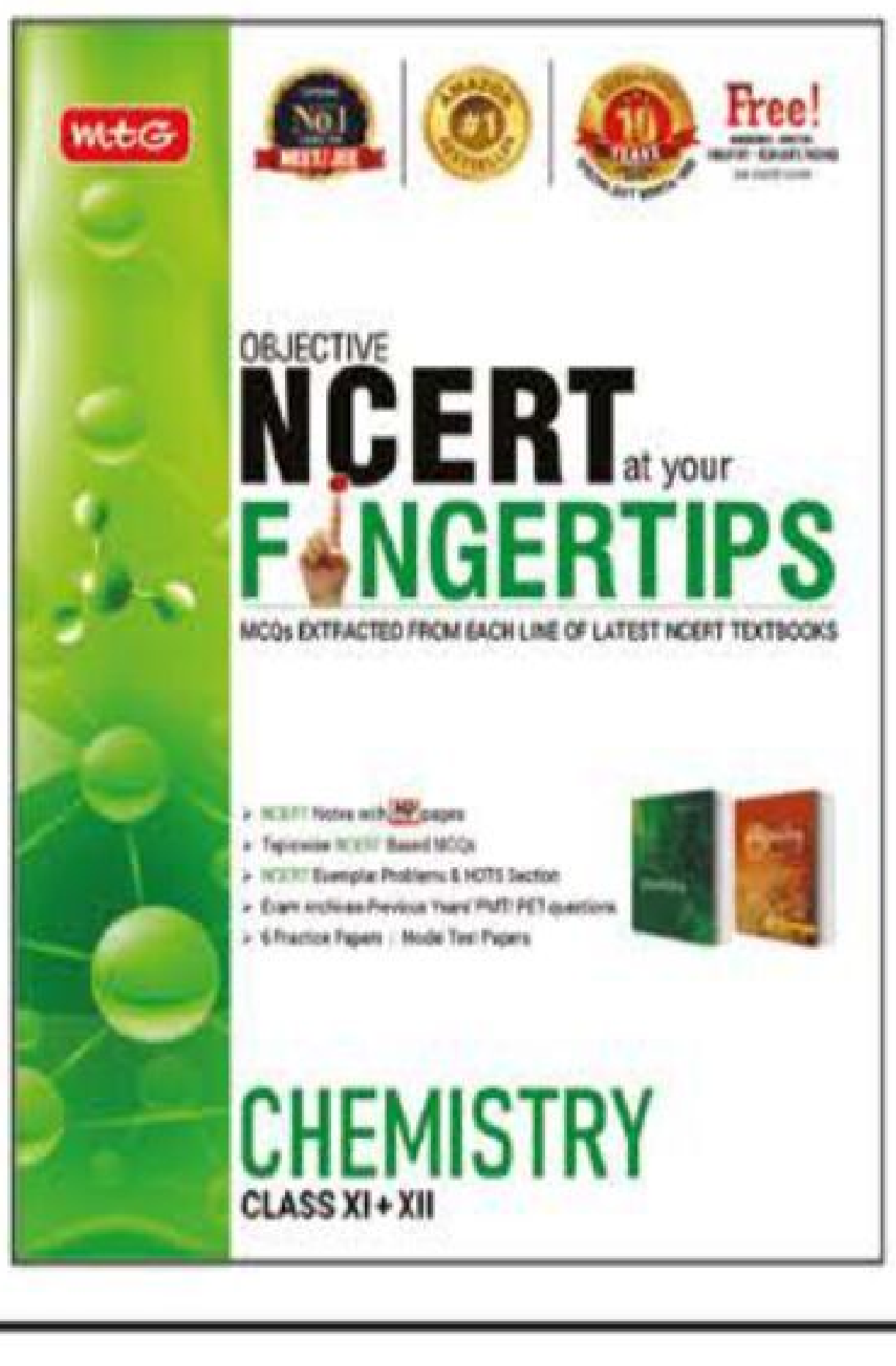
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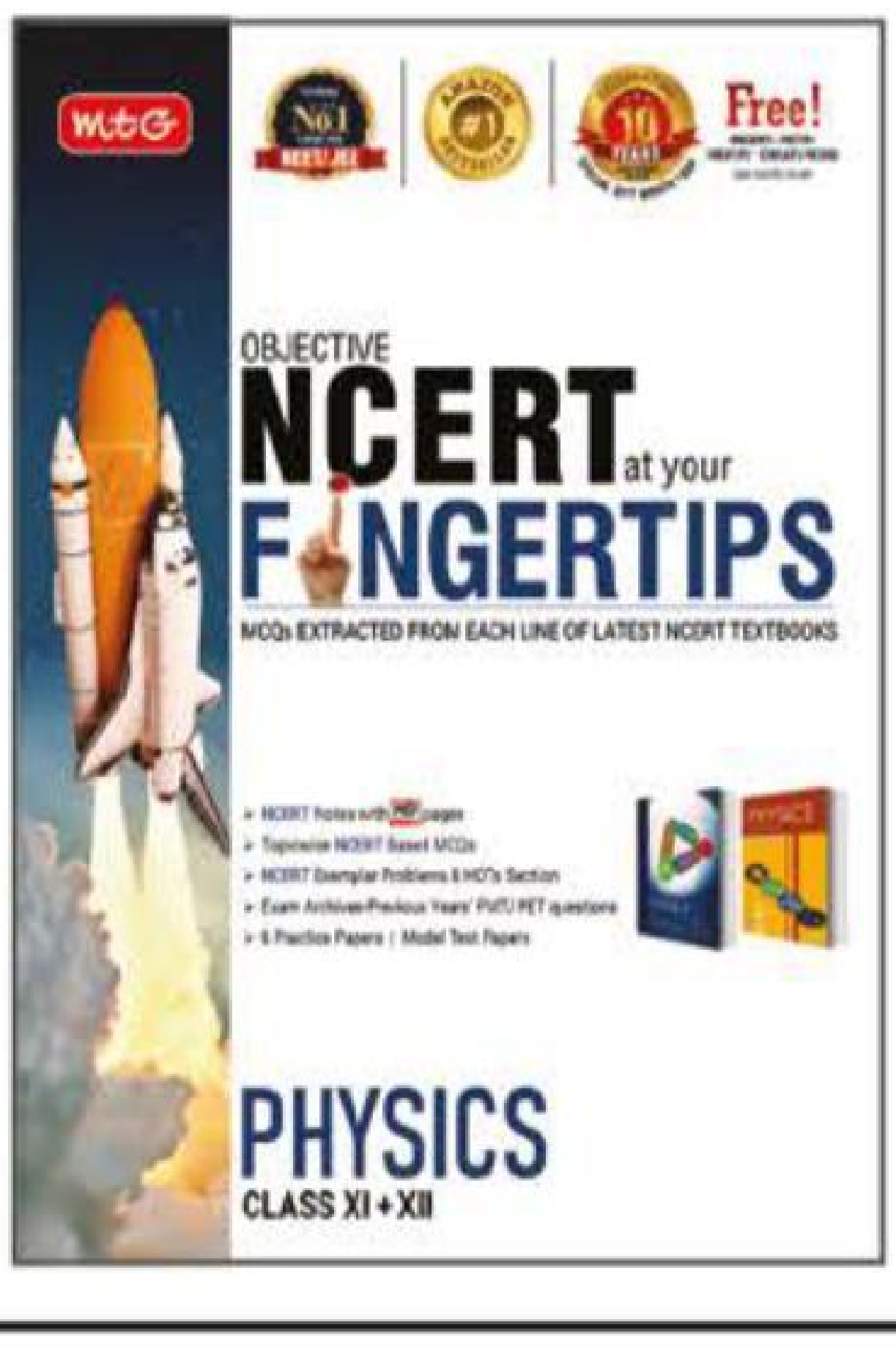
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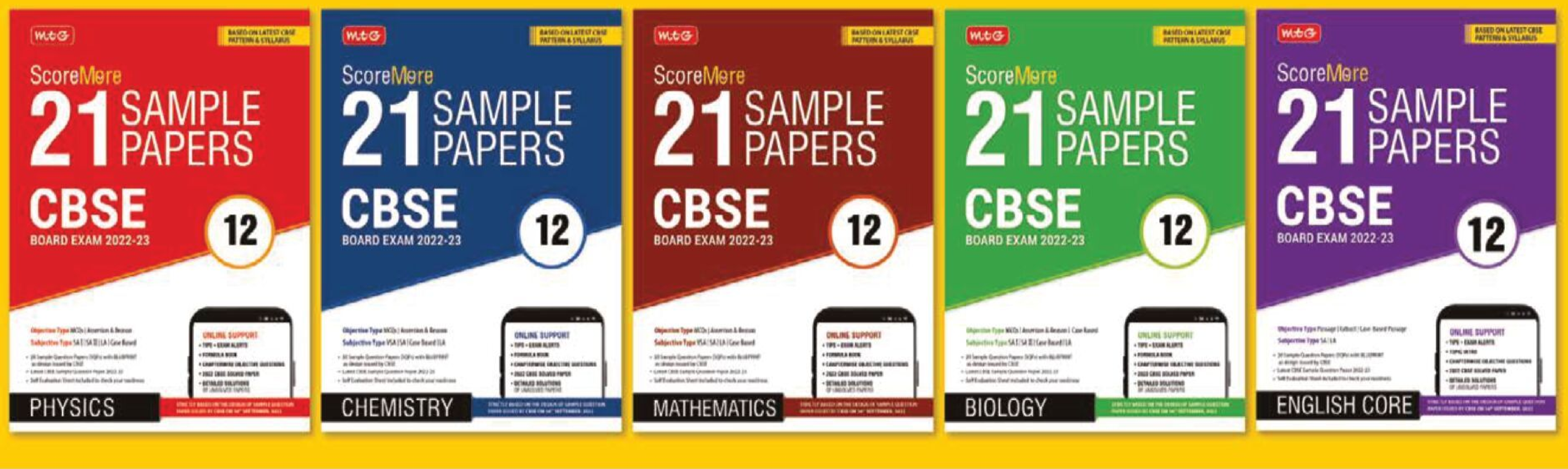

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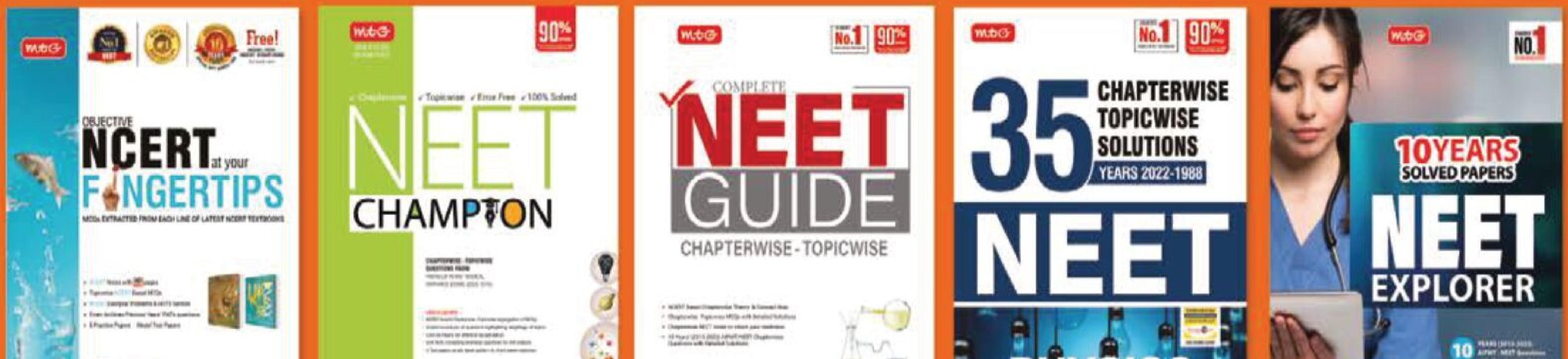
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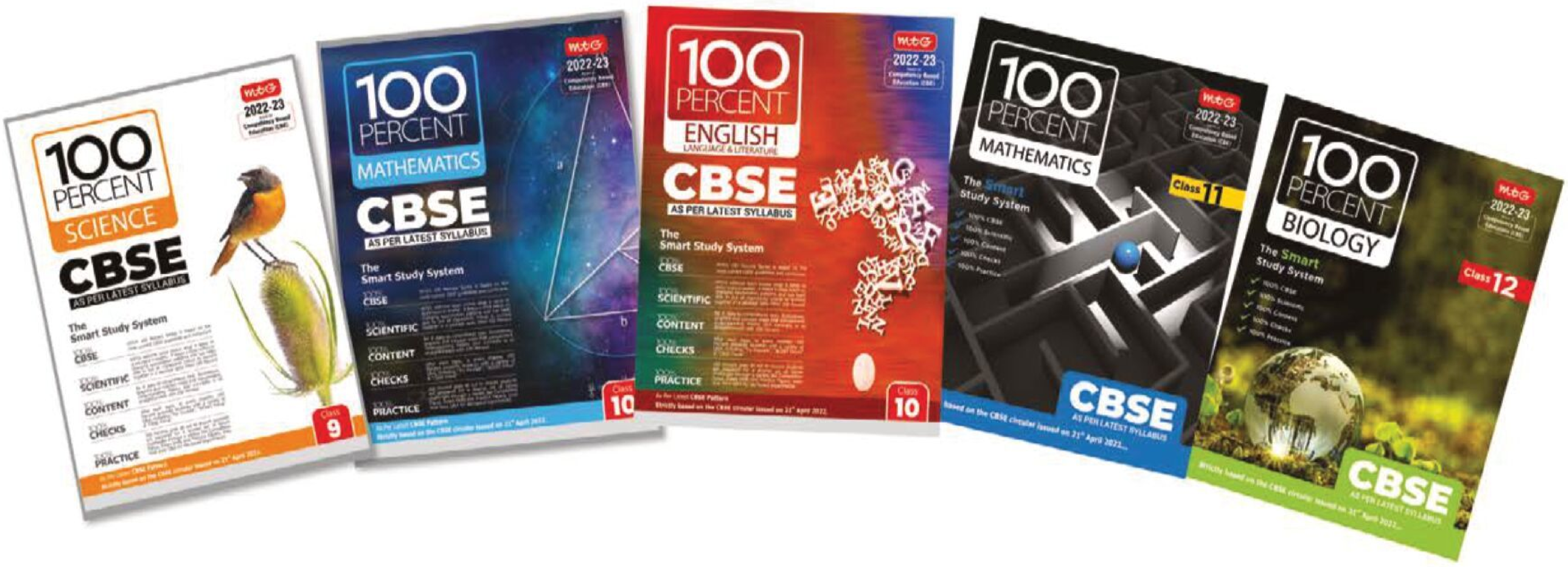
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A Very Happy New Year

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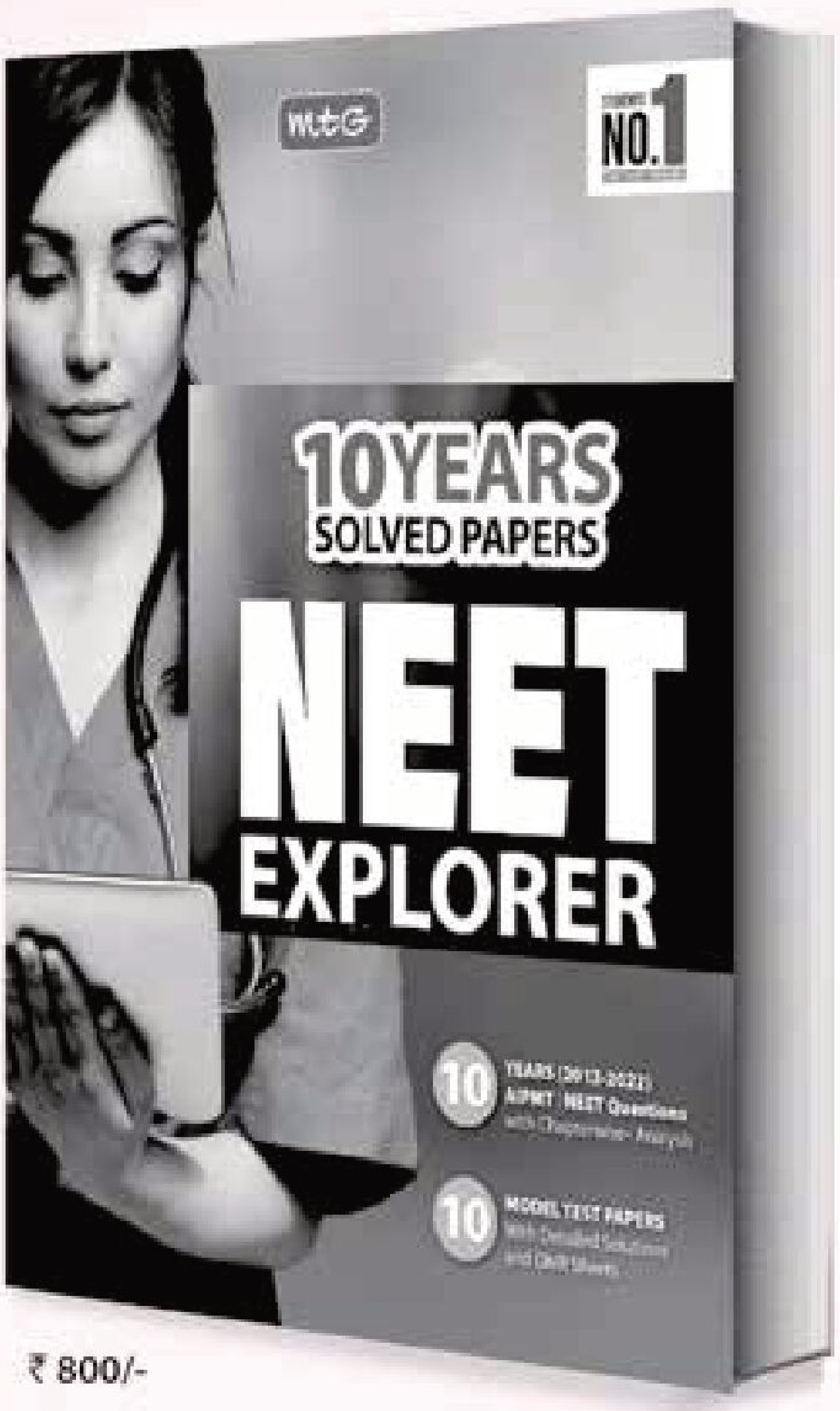
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Satvik M

My Success Story

NEET 2022 (700/720)

- **MTG : Why did you choose medical stream?**
  Satvik : I chose this stream because it's a noble and respectable profession and I wanted to experience it. Also the motive of service to humanity urged me towards it.

- **MTG : What exams have you appeared for and what status/rank in them?**
  Satvik : (i) NEET - 58
  (ii) CET - 241

- **MTG : How did you prepare for the examination?**
  Satvik : We were given strict and helpful timetables by our institute and I followed it. Teachers were with us till the end and guided us every day. Revising the topic on same day, it is being taught is important.

- **MTG : Did you refer MTG Books for NEET preparation?**
  Satvik : I used Objective NCERT Fingertips, NEET Champion and 34 years NEET Chapterwise Topicwise from MTG.

- **MTG : How these books helped you?**
  Satvik : MTG books have well framed and standardised questions which helped me in my preparation. Topicwise questions were very helpful.

- **MTG : Which MTG Books you would like to recommend to future NEET aspirants?**
  Satvik : The same books that I have used Objective NCERT Fingertips, NEET Champion and 34 years NEET Chapterwise Topicwise, are highly recommended for NEET aspirants.

- **MTG : How can MTG Magazines be useful to NEET aspirants?**
  Satvik : I have followed MTG magazines which have concept maps and practice papers for various competitive exams which helped me in my preparation.

- **MTG : On which topic and chapters you laid more stress in each subject?**
  Satvik : Biology - Genetics and Ecology
  Chemistry - Inorganic chemistry
  Physics - Mechanics

- **MTG : How much time you used to devote for NEET preparation? How did you manage it with school studies?**
  Satvik : Apart from the classes, I used to study for 6-8 hours on daily basis, giving 2 hours minimum to each subject with sufficient breaks.

- **MTG : Any extra coaching?**
  Satvik : I took coaching from Parishrama NEET Academy at Bengaluru.

- **MTG : Which subjects/topics you were strong/weak at?**
  Satvik : I was strong in organic chemistry because I found it interesting. When it comes to my weak subject, it would be Physics and the topic which I felt tough was mechanics.

- **MTG : How did you prepare for NEET and other exams?**
  Satvik : I used to follow my timetable strictly, with time for other activities, which I love. Preparing that day's topic on same day itself and revising it is a must.

- **MTG : In your words what are the components of an ideal preparation plan?**

Satvik : Preparing a neat strategic timetable and strictly following it, taking care of health and stress and revision strategy are the important keys.

- **MTG : What role did the following play in your success:**
  (a) Parents (b) Teachers and School

  Satvik : (a) My parents were obviously there at my back, motivating me when I was down and encouraging me to do it whatever it takes.

  (b) My teachers were very supportive and helped me till the end and my academy provided every kind of support.

- **MTG : Your family background?**

  Satvik : My father is a pharmacist and my mother is a homemaker.

- **MTG : What mistake you think you shouldn't have made?**

  Satvik : Fear of being in exam is the most crucial aspect for students. The fear makes you attempt the questions in wrong way and commit mistakes. The exam hall mindset should be relaxed. I know it's easy to say but not easy to act. Try your best to calm yourself in examination room.

- **MTG : Was this your first attempt?**

  Satvik : No, this was my second attempt of NEET.

- **MTG : What do you think is the secret of your success?**

  Satvik : Dedication towards your goal and the hardwork needed for it is the key to my success.

- **MTG : Had you not been selected then what would have been your future plan?**

  Satvik : If I had not been selected, I would think of joining the engineering platform because I did good there also.

- **MTG : What advice would you like to give our readers who are MEDICAL aspirants?**

  Satvik : Follow a proper strategy, take care of your health, give time to other activities, revise and follow timetable and do not loose your focus.

All the Best!☺☺

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I	Column II
1. NLUMISCENECOIBE	(a) A step of decomposition where water soluble inorganic nutrients go down into soil horizon and get precipitated as unavailable salts.
2. MARDEHOCRIT	(b) It is a phenomenon which results in alteration of DNA sequence and changes in genotype and phenotype of an organism.
3. RACYPIIOB	(c) A procedure through which a piece of DNA is introduced in a host bacterium.
4. SDASIENIKI	(d) The process where plants are exposed to low light to hasten flowering.
5. HYCEAEPOEAHP	(e) A stage of meiotic prophase-I marked by terminalisation of chiasmata.
6. FORNSTRATIMAON	(f) Free living fungus found in root ecosystems, which exerts biocontrol over several plant pathogens.
7. TINOTUMA	(g) The use of bio-resources by companies and other organisations without proper authorisation from countries concerned.
8. ACHLEING	(h) Algae in which individual store food in the form of mannitol and laminarin and fucoxanthin is the major pigment.
9. IRANALTONISVE	(i) The property of a living organism to emit light.
10. TIONTFICAARTSI	(j) The vertical distribution of different plant species occupying different levels.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

CHAPTERWISE PRACTICE PAPER 2023

CUET (UG)

Exam on
21st to 31st
May 2023

UNIT : ECOLOGY

SERIES - V

- Organisms and Populations
- Biodiversity and Conservation
- Ecosystem
- Environmental Issues

Section II of CUET (UG) is domain specific. In this section of Biology 40 questions to be attempted out of 50.

Time Allowed : 45 Minutes

Maximum Marks : 200

Multiple Choice Questions (MCQs)

1. Slash and burn agriculture, which is commonly known as Jhum cultivation in the north-eastern states of India, leads to

(a) deforestation (b) reforestation
(c) afforestation (d) water-logging.

2. Match mean annual precipitation in column I with the biome in column II and choose the right option.

	Column I		**Column II**
(i)	0-50 cm	A.	Tropical forest
(ii)	50-100 cm	B.	Coniferous forest
(iii)	150-400 cm	C.	Grassland
(iv)	50-250 cm	D.	Desert

(a) (i)-D (ii)-C (iii)-A (iv)-B
(b) (i)-C (ii)-A (iii)-B (iv)-D
(c) (i)-C (ii)-D (iii)-A (iv)-B
(d) (i)-B (ii)-D (iii)-A (iv)-C

3. The relation between species richness and area is described on a logarithmic scale by the equation ______ [where S = species richness, A = area, Z = slope of the line (regression coefficient), C= Y-intercept].

(a) $\log S = \log C - Z \log A$
(b) $\log S = Z \log A$
(c) $\log S = \log C + Z \log A$
(d) $\log S = \log C$

4. Read the given statements and select the correct option.

Statement I : Regulators show maximum geographical distribution.

Statement II : Regulators are capable of thermoregulation and osmoregulation.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

5. Which of the following is/are correct regarding Montreal Protocol?

(i) It is concerned regarding persistent organic pollutants.
(ii) It controls global warming and climate change.
(iii) Its aim is to control the emission of ozone depleting substances.
(iv) It is an international treaty signed to protect ozone layer.

(a) (i) and (ii) (b) (iii) only
(c) (iii) and (iv) (d) (i) and (iii)

6. Identify the ecologist from the given hints.

(i) He carried out long-term ecosystem experiments using outdoor plots.
(ii) In his experiments he showed that "increased diversity contributed to higher productivity".

(a) Ahmed Khan (b) David Tilman
(c) Stanley Cohen (d) Ernest Chain

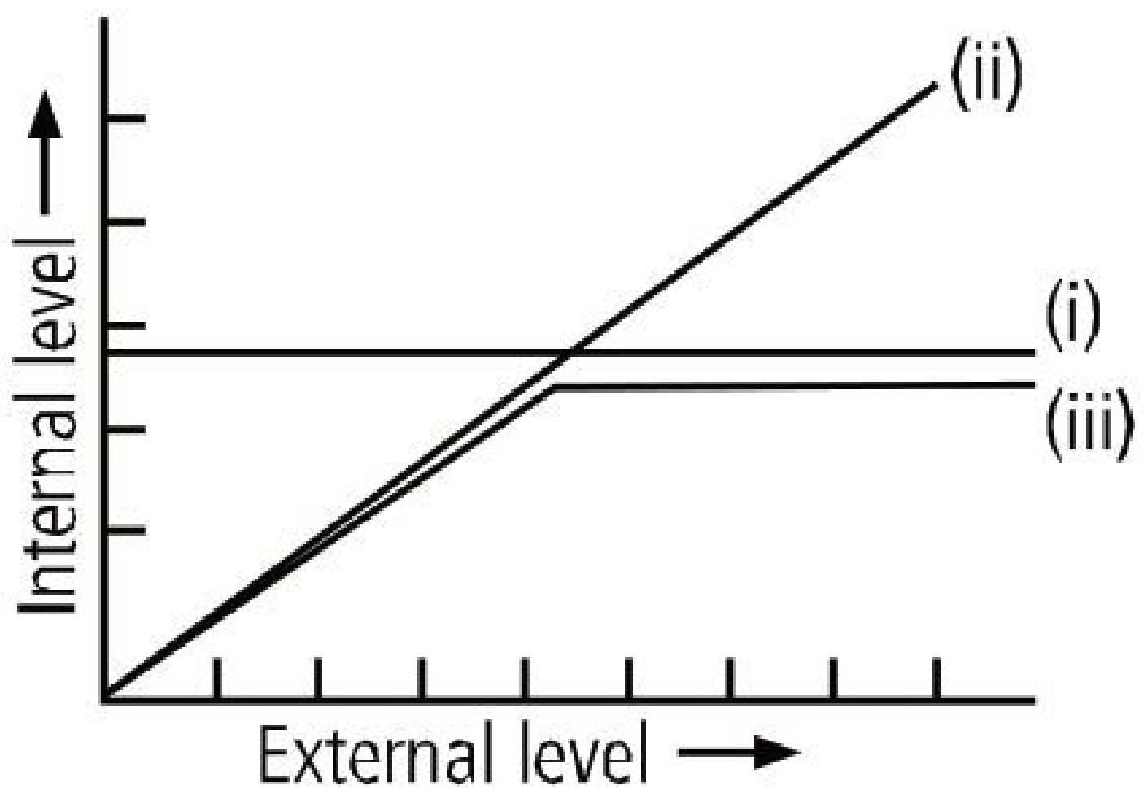
7. Read the given statements and select the correct option.

Statement I : Phosphorus cycle is sedimentary cycle.

Statement II : Gaseous exchanges of phosphorous between organism and environment are negligible.

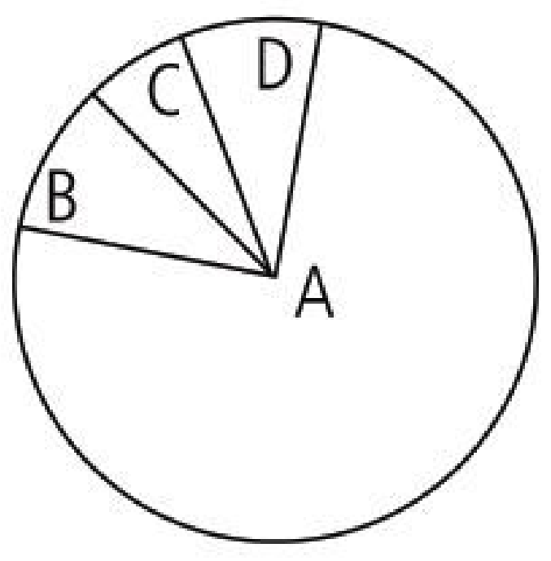
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

8. The figure given below is a diagrammatic representation of response of organisms to abiotic factors. What do (i), (ii) and (iii) represent respectively?



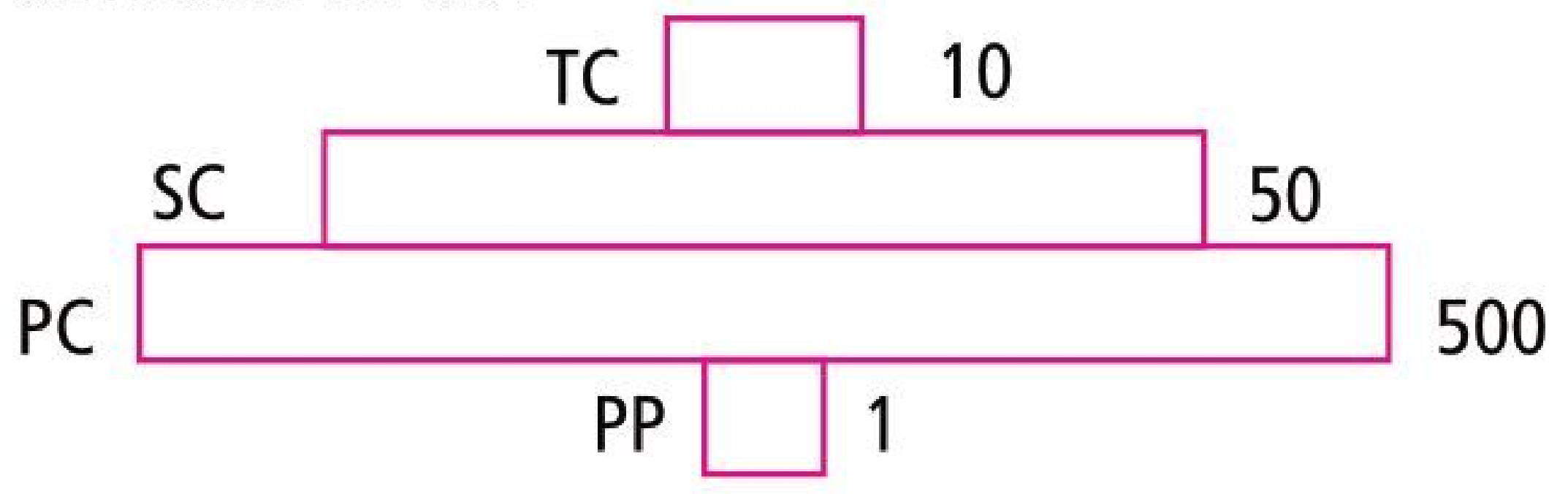
	(i)	(ii)	(iii)
(a)	Conformer	Regulator	Partial regulator
(b)	Regulator	Partial regulator	Conformer
(c)	Partial regulator	Regulator	Conformer
(d)	Regulator	Conformer	Partial regulator

9. Given here is a pie chart representation of the extent of global diversity of invertebrates. What do the four portions (A-D) represent respectively?



	A	B	C	D
(a)	Insects	Crustaceans	Other animal groups	Molluscs
(b)	Crustaceans	Insects	Molluscs	Other animal groups
(c)	Molluscs	Other animal groups	Crustaceans	Insects
(d)	Insects	Molluscs	Crustaceans	Other animal groups

10. Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels?



(a) Level PC is "insects" and level SC is "small insectivorous birds".
(b) Level PP is "phytoplanktons" in sea and "whale" on top level TC
(c) Level one PP is "pipal trees" and the level SC is "sheep".
(d) Level PC is "rats" and level SC is "cats".

11. Match column I with column II.

	Column I		Column II
P.	Producer	(i)	Herbivores
Q.	Primary consumer	(ii)	Green plants
R.	Secondary consumer	(iii)	Saprotrophs
S.	Decomposer	(iv)	Carnivores

(a) P-(i), Q-(ii), R-(iii), S-(iv)
(b) P-(ii), Q-(i), R-(iv), S-(iii)
(c) P-(ii), Q-(iv), R-(iii), S-(i)
(d) P-(iii), Q-(ii), R-(i), S-(iv)

12. Which of the following statements regarding responses of organisms to abiotic factors is false?
(a) All birds and mammals are capable of thermoregulation.
(b) Majority of animals and nearly all plants cannot maintain a constant internal environment.
(c) Shivering is a kind of exercise which produces heat and raises body temperature.
(d) Very small animals are commonly found in polar regions as they have to spend less energy to generate body heat.

13. BOD refers to
(a) the oxygen required for bacteria to grow in 1 Litre of effluent
(b) the amount of oxygen consumed if all the organic matter in 1000 mL of water is oxidised by bacteria
(c) the amount of oxygen released if all the organic matter in 1000 mL of water is oxidised by bacteria
(d) the amount of oxygen released when all the organic matter in 1 litre of water is consumed by bacteria.

14. Consider the following statements concerning food chains.
(A) Removal of 80% tigers from an area will result in greatly increased growth of vegetation.
(B) Removal of most of the carnivores will result in an increased population of deers.
(C) The length of food chains is generally limited to 3-4 trophic levels due to energy loss.
(D) The length of food chains may vary from 2 to 8 trophic levels.
Which two of the above statements are correct?
(a) A, D (b) A, B (c) B, C (d) C, D

15. In an area where DDT had been used extensively, the population of birds declined significantly because
(a) birds stopped laying eggs
(b) earthworms in the area got eradicated
(c) cobras were feeding exclusively on birds
(d) many of the birds eggs laid did not hatch.

16. Match the following and select the correct option.

	Column I		Column II
A.	Bears	1.	Diapause
B.	Snail	2.	Hibernation
C.	Zooplanktons	3.	Dormancy
D.	Seeds	4.	Aestivation

(a) A-3, B-4, C-1, D-2
(b) A-2, B-1, C-4, D-3
(c) A-4, B-1, C-2, D-3
(d) A-2, B-4, C-1, D-3

17. Read the given statements and select the correct option.

Statement I : Irrigation without proper drainage of water leads to water logging in the soil.

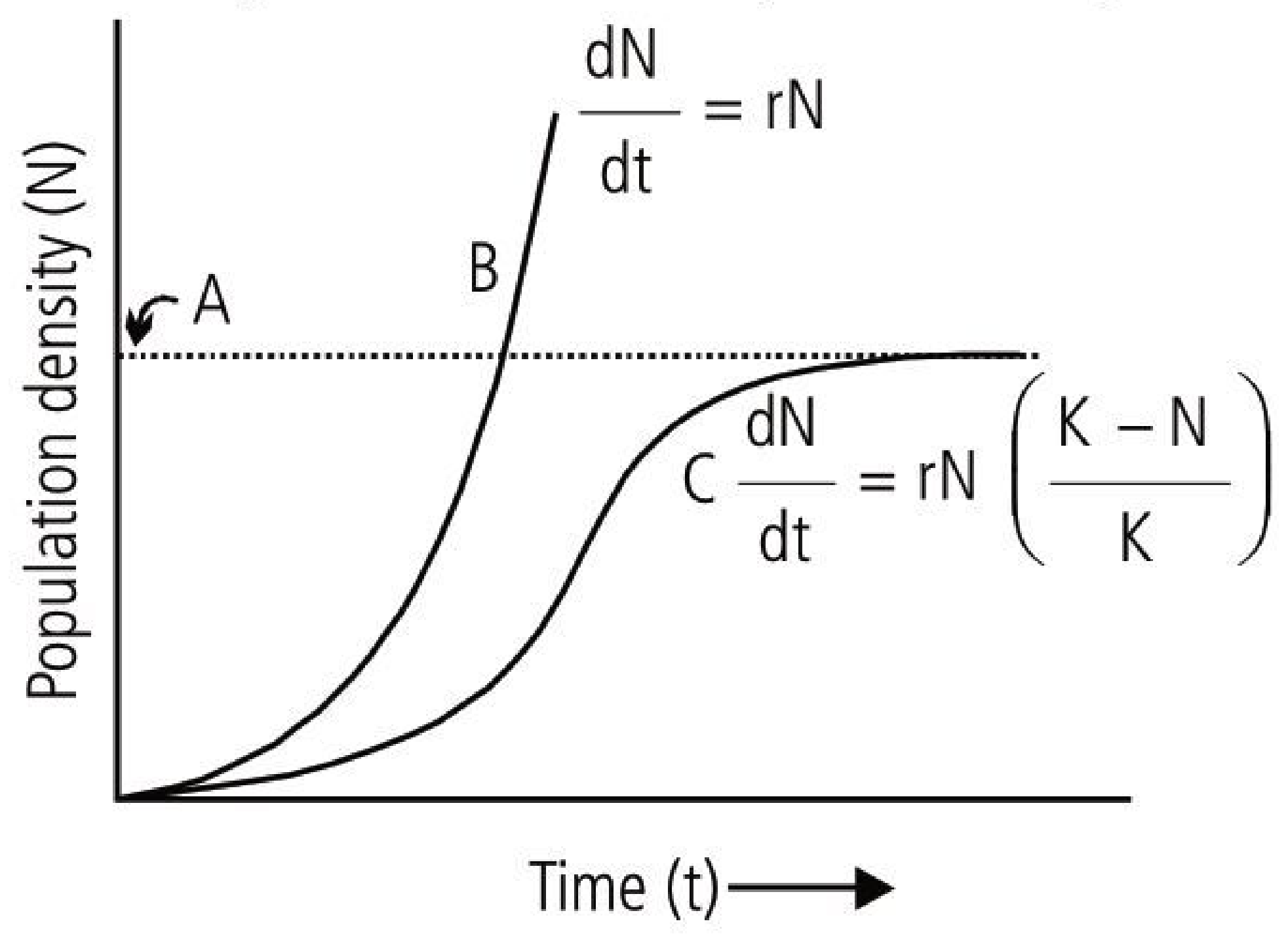
Statement II : Water logging draws salt to the soil surface, which is deposited as a thin crust on the land surface or starts collecting at the roots of the plants.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

18. Which one of the following is not a gaseous biogeochemical cycle in ecosystem?

(a) Sulphur cycle (b) Hydrogen cycle
(c) Nitrogen cycle (d) Carbon cycle

19. Which is correctly labelled with respect to the given diagram?



(a) B : Logistic curve (b) C : Carrying capacity
(c) C : Exponential curve (d) A : Carrying capacity

20. If there was no carbon dioxide in the earth's atmosphere, the temperature of the earth's surface would be

(a) less than the present level
(b) same as the present level
(c) dependent on the oxygen content in the atmosphere
(d) more than the present level.

21. If 20 J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following food chain?

Plant ⟶ Mice ⟶ Snake ⟶ Peacock

(a) 0.02 J (b) 0.002 J
(c) 0.2 J (d) 0.0002 J

22. Match the animals given in column I with their location in column II.

	Column I		Column II
A.	Dodo	(i)	Africa
B.	Quagga	(ii)	Russia
C.	Thylacine	(iii)	Mauritius
D.	Steller's sea cow	(iv)	Australia

Choose the correct match from the following.

(a) A-(i), B-(iii), C-(ii), D-(iv) (b) A-(iv), B-(iii), C-(i), D-(ii)
(c) A-(iii), B-(i), C-(ii), D-(iv) (d) A-(iii), B-(i), C-(iv), D-(ii)

23. Which of the following is correct?

(a) Population change = (Birth + immigration) – (death + emigration)
(b) Population change = (Birth + immigration) + (death + emigration)
(c) Population change = (Birth + emigration) + (death – immigration)
(d) Population change = (Birth – immigration) – (death + emigration)

24. Which of the following statements is not true?

(a) The biodiversity decreases with increasing latitude.
(b) The biodiversity decreases with increasing altitude.
(c) The fishes show greatest biodiversity among vertebrates.
(d) The biodiversity of bryophytes is greater than that of angiosperms.

25. The pioneer species in xerarch and hydrarch succession respectively are

(a) lichens and sedges
(b) lichens and rooted hydrophytes
(c) phytoplanktons and lichens
(d) lichens and phytoplanktons.

26. Air quality of Delhi has significantly improved between 1997 and 2005 due to substantial fall in levels of (i) and (ii).

(a) (i)-CO (ii)-N_2O
(b) (i)-CO_2 (ii)-SO_2
(c) (i)-N_2O (ii)-SO_2
(d) (i)-CO (ii)-CO_2

27. A biologist studied the population of rats in a barn. He found that the average natality was 250, average mortality 240, immigration 20 and emigration 30. The net increase in population is

(a) 05 (b) zero (c) 10 (d) 15.

28. Match the environmental activist in Column I with the environmental issue in Column II and choose the right option.

Column I		Column II	
(i)	Ramesh Chandra Dagar	A.	Conservation of forests
(ii)	Ahmed Khan	B.	Organic farming
(iii)	Amrita Devi	C.	Plastic waste recycling

(a) (i)-B, (ii)-C, (iii)-A (b) (i)-C, (ii)-A, (iii)-C
(c) (i)-A, (ii)-B, (iii)-C (d) (i)-B, (ii)-A, (iii)-C

29. Read the given statements and select the correct option.

Statement I : A network of food chains existing together in an ecosystem is known as a food web.

Statement II : An animal like kite cannot be a part of a food web.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

30. Match column I with column II and select the correct option from the codes given below.

	Column I		**Column II**
A.	Commensalism	(i)	One affected, other unaffected
B.	Parasitism	(ii)	One benefitted, other unaffected
C.	Mutualism	(iii)	Both are benefitted
D.	Amensalism	(iv)	One benefitted, other harmed

(a) A-(iv), B-(ii), C-(iii), D-(i)
(b) A-(iii), B-(iv), C-(ii), D-(i)
(c) A-(ii), B-(iv), C-(iii), D-(i)
(d) A-(ii), B-(iv), C-(i), D-(iii)

31. Which of the following metals are recovered during recycling process of e-wastes?
(a) Copper
(b) Iron
(c) Gold
(d) All of these

32. Which of the following processes will be most adversely affected if microorganisms are removed from a forest ecosystem?
(a) Solar energy fixation and nutrient cycling
(b) Decomposition of organic matter and photosynthesis
(c) Nitrogen fixation and decomposition of organic matter
(d) Carbon assimilation and nitrogen fixation

33. The eagle can be placed in which of the following trophic level?
(a) T_2
(b) T_3
(c) T_4
(d) Both T_3 and T_4

34. Consider the following four conditions (i) - (iv) and select the correct pair of them as adaptation to environment in desert lizards.
(i) Burrowing in soil to escape from high temperature
(ii) Losing heat rapidly from the body during high temperature
(iii) Bask in sun when temperature is low
(iv) Insulating body due to thick fatty dermis
(a) (iii) and (iv)
(b) (i) and (iii)
(c) (ii) and (iv)
(d) (i) and (ii)

35. Nuclear reactor malfunction in any country is a cause of concern because radiation released from it causes
(a) biomagnification
(b) mutations at a very high rate
(c) thinning of ozone layer
(d) eutrophication

36. Read the given statements and select the correct option.
Statement I : For many animals, light is as important as for plants.
Statement II : Many animals use the diurnal and seasonal variations in light intensity and duration as cues for timing their foraging, reproductive and migratory activities.
(a) Both statement I and statement II are correct .
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

37. Waking up to a bulbul's song in the morning is related to
(a) narrow utilitarian
(b) broadly utilitarian
(c) ethical
(d) both (b) and (c).

38. Which of the following statements regarding energy flow are false?
I. The detritus food chain begins with dead organic matter.
II. In aquatic ecosystem, detritus food chain is the major conduit for energy flow.
III. In terrestrial ecosystem, a larger fraction of energy flows through grazing food chain.
IV. Producers belong to the first trophic level of the food chain.
(a) II and III only
(b) III and IV only
(c) I and IV only
(d) I and II only

39. Read the given statements and select the correct option.
Statement I : Genetic diversity comprises of diversity at the species level.
Statement II : Amphibian species diversity is more in Eastern Ghats than the Western Ghats.
(a) Both statements I and II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I is incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

40. The rate of formation of new organic matter by deer in a forest ecosystem is called
(a) standing crop
(b) primary productivity
(c) net primary productivity
(d) secondary productivity.

Case Based MCQs

Case I : Read the passage given below and answer the following questions from 41 to 45.

Food chains X and Y form an interconnection. 'X' initiates with a wheat grass, whose population supports a fewer number of grasshoppers, frogs, snakes and a few falcons. 'Y' starts with dead decaying leaves of wheat grass, which are eaten by earthworms and then food chain is continued with frog of food chain X.

41. The ultimate source of energy to X and Y is
(a) producers
(b) organic molecules
(c) carbohydrate
(d) solar radiation.

42. Identify the types of X and Y food chains.

	X	Y
(a)	Detritus	Grazing
(b)	Grazing	Detritus
(c)	Detritus	Detritus
(d)	Grazing	Grazing

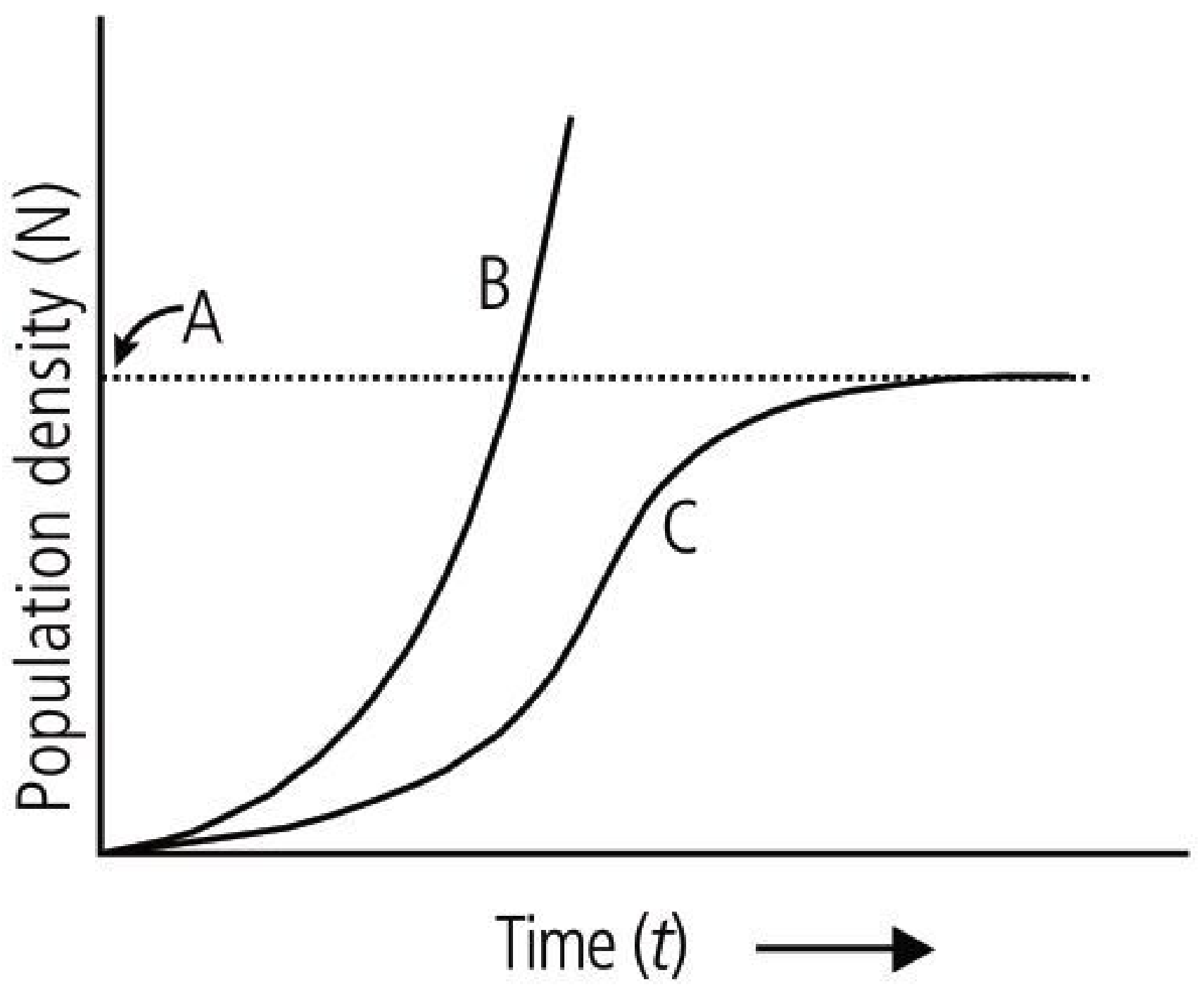
43. What will happen if we eliminate primary consumer from the food chain Y ?
(a) Dead matter of wheat grass will accumulate.
(b) The food chain will remain unaffected.
(c) Nutrient cycling will get affected.
(d) Both (a) and (c)

44. The movement of energy in X and Y type of food chain is
(a) always unidirectional
(b) sometimes unidirectional
(c) always bidirectional
(d) undeterminable.

45. Which of the following statements is/are incorrect?
(a) Food chain X will form an inverted pyramid of energy.
(b) Food chains X and Y will form a food web.
(c) Snake can be considered as top carnivore.
(d) Both (a) and (c)

Case II : Read the passage and graph given below and answer the questions from 46 to 50.

The graph of a population with time shows specific pattern. The given graph shows population growth curve with respect to time. Consider *N* is the population density at time *t*, *k* is carrying capacity and *r* is intrinsic rate of natural increase for the population.



46. Select the option that correctly identifies A, B and C.
(a) A- Carrying capacity; B- Exponential growth curve; C- Logistic growth curve
(b) A- Carrying capacity; B- Logistic growth curve; C- Exponential growth curve
(c) A- Logistic growth curve; B- Exponential growth curve; C- Carrying capacity
(d) A-Exponential growth curve; B- Carrying capacity; C- Logistic growth curve

47. At equilibrium phase of curve C,
(a) $K > N$
(b) $K < N$
(c) $K = N$
(d) $K = 1/N$.

48. In the given graph, the population shown by C can be described by
(a) $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$
(b) $\frac{dN}{dt} = tN\left(\frac{K-N}{N}\right)$
(c) $\frac{dN}{dt} = rN\left(\frac{K-N}{N}\right)$
(d) $\frac{dN}{dt} = tN\left(\frac{K-N}{K}\right)$.

49. Why population fluctuates when it reaches the carrying capacity?
(a) Due to limited resources
(b) Due to exponential growth
(c) Due to unlimited natural resources
(d) Due to increased reproductive rate

50. Equation for population growth curve B is
(a) $\frac{dN}{dt} = rN$
(b) $N_t = N_0e^{rt}$
(c) $\frac{dN}{dt} = rN\,\frac{(K-N)}{K}$
(d) both (a) and (b).

SOLUTIONS

1. **(a) :** Jhum cultivation is a local name for slash and burn agriculture practiced by the tribal groups in the north-eastern states of India like Meghalaya, Mizoram and Nagaland. This system involves cleaning a piece of land by setting fire and using the area for growing crops of agricultural importance such as rice, vegetables or fruits. After a few cycles, the land loses fertility and a new area, is chosen.

2. **(a)**

3. **(c) :** German naturalist and geographer Alexander von Humboldt while exploring the wilderness of South American jungles found that within a region the species richness increased with increasing area but upto a certain limit. On this basis, he proposed species area relationship curve. The relationship between species richness and area turned out to be rectangular hyperbola for a wide variety of taxa whether they are birds, bats, freshwater fish or flowering plants. On a logarithmic scale, it is a straight line. It is described by the equation: $\log S = \log C + Z \log A$

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1.	(a)	**2.**	(b)	**3.**	(d)	**4.**	(c)	**5.**	(a)
6.	(a)	**7.**	(d)	**8.**	(b)	**9.**	(b)	**10.**	(d)
11.	(a)	**12.**	(c)	**13.**	(c)	**14.**	(b)	**15.**	(b)
16.	(b)	**17.**	(b)	**18.**	(a)	**19.**	(c)	**20.**	(d)
21.	(a)	**22.**	(b)	**23.**	(a)	**24.**	(b)	**25.**	(d)
26.	(b)	**27.**	(c)	**28.**	(b)	**29.**	(d)	**30.**	(a)
31.	(b)	**32.**	(c)	**33.**	(a)	**34.**	(c)	**35.**	(c)
36.	(b)	**37.**	(d)	**38.**	(b)	**39.**	(b)	**40.**	(a)

Here S is species richness, Z is slope of line or regression coefficient, C is Y intercept and A is area.

4. **(a) :** Due to the ability of regulating temperature and osmolarity, regulators show wide geographical distribution.

5. **(c) :** Montreal protocol on substances that deplete the ozone layer is a protocol to the Vienna Convention for the protection of the ozone layer. It is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989.

6. **(b)** 7. **(a)**

8. **(d) :** Some organisms are able to maintain homeostasis by physiological (sometimes behavioural also) means which ensures constant body temperature, constant osmotic concentration, etc. They are known as regulators. A majority of animals and plants cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature. These animals and plants are simply conformers. During the course of evolution, the costs and benefits of maintaining a constant internal environment are taken into consideration. Some species have evolved the ability to regulate, but only over a limited range of environmental conditions, beyond which they simply conform. They are known as partial regulators.

9. **(d)** 10. **(a)**

11. **(b) :** Green plants utilize solar radiation and make food hence, they are known as producers. The herbivores feed on these producers hence, named as primary conservers. Organisms that rely on herbivores for their food are carnivores (secondary consumers). Decomposers are saprotrophs.

12. **(d) :** Heat loss or heat gain is a function of surface area. Since small animals have a larger surface area relative to their volume they tend to lose body heat very fast, when it is cold outside and they have to expend much more energy to generate body heat through metabolism. Hence very small animals are rarely found in polar areas.

13. **(b)**

14. **(c) :** Removal of 80% tigers from an area will result in decrease growth of vegetation because on removing tigers, number of deers (which feed on grass) increases. The length of food chain is generally limited to 3-4 trophic levels. This is at each trophic a lot of the energy is lost in respiration and to drive the organisms metabolism so less energy is left to support higher trophic levels.

15. **(d) :** Higher amounts of DDT disturb calcium metabolism of birds resulting in thinning of egg shells and their premature breaking that kills the embryos. Thus many of the eggs laid by birds did not hatch.

16. **(d)** 17. **(a)**

18. **(a) :** Biogeochemical cycles are of two types—sedimentary and gaseous. In sedimentary cycles, materials involved in circulation are nongaseous and the reservoir pool is lithosphere *e.g.*, sulphur and phosphorus cycle. Nitrogen, hydrogen and carbon has gaseous cycle.

19. **(d) :** The given figure shows population growth curve, in which *A* is carrying capacity, *B* is exponential growth curve and *C* is logistic growth curve.

20. **(a) :** CO_2 is a greenhouse gas *i.e.*, it traps a substantial amount of long-wave infrared radiation emitted back by earth's surface and do not let it leave the earth's atmosphere. It causes increased temperature. Hence, in the absence of

PUBLIC NOTICE

NTA Examination Calendar for Academic Year 2023-24

The Ministry of Education (MoE), Government of India (GoI) has established the National Testing Agency (NTA) as an independent, autonomous, and self-sustained premier testing organisation under the Societies Registration Act (1860) for conducting efficient, transparent, and international standardized tests in order to assess the competency of candidates for admission to premier higher education institutions with a mission to improve equity and quality in education by developing and administering research-based valid, reliable, efficient, transparent, fair and international level assessments.

For the **Academic year 2023-24,** following is the Calendar for some major examinations to be conducted by the NTA :

S.No.	Name of Examination	Dates of Examinations	Reserve Dates
1.	Joint Entrance Examination [JEE (Main)] – 2023 Session 1	24, 25, 27, 28, 29, 30, 31 January 2023	01, 02, 03 February 2023
2.	Joint Entrance Examination [JEE (Main)] – 2023 Session 2	06, 08, 10, 11, 12 April 2023	13, 15 April 2023
3.	ICAR AIEEA 2023	26, 27, 28, 29 April 2023	
4.	National Eligibility cum Entrance Test [NEET (UG)] – 2023	07 May 2023	
5.	Common University Entrance Test (CUET) 2023	21 to 31 May 2023	01 to 07 June 2023

For further clarification related to the examination dates and other instructions, the Candidates are advised to visit the official website of NTA **www.nta.ac.in** for the latest updates.

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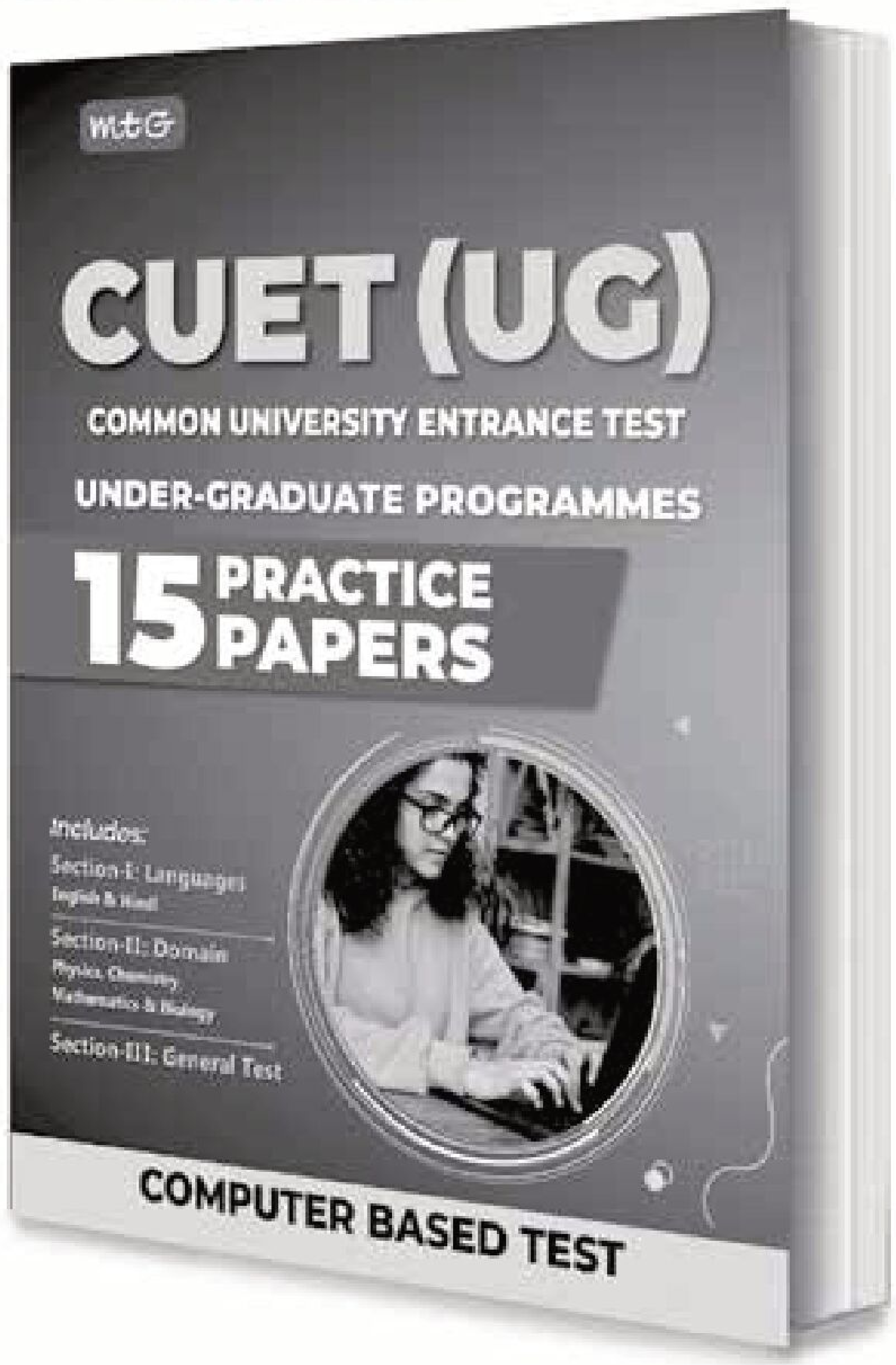
From the academic session 2022-23, admissions to Undergraduate Programmes in all central universities in the country will take place through Central University Entrance Test (CUET).

To help students with their preparation for the above test MTG is coming up with the book CUET 2023 which caters the Science Stream for the test. The MTG CUET (UG) – 2023 title covers 15 Practice papers which include following subjects in each practice paper :

Section IA Languages : English and Hindi

Section II Domain : Physics, Chemistry, Mathematics and Biology

Section III General Test : General Knowledge, Current Affairs, General Mental Ability, Numerical Ability, Quantitative Reasoning, Logical and Analytical Reasoning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CO_2 in our atmosphere, temperature of earth's surface would have been less than the present level.

21. **(a) :** According to the ten percent law given by Lindeman (1942), only 10% of the total energy is transferred at each trophic level. From producers, 10% of total energy is transferred to the primary consumers (herbivores). Herbivores are eaten by primary carnivores. Only 10% of the herbivores productivity is utilised for raising productivity of primary carnivores. The rest is consumed in ingestion, respiration, maintenance of body heat and other activities. Higher carnivores similarly are able to retain only 10% of energy present in primary carnivores. Accordingly, if plant trapped 20 J of energy, mice will have 2 J, snake will have 0.2 J and hence, peacock will have 0.02 J of energy.

22. **(d)** 23. **(a)**

24. **(d) :** The biodiversity of bryophytes is less than that of angiosperms.

25. **(d) :** The species that invade a bare area are called pioneer species. In primary succession in xerarch these are usually lichens which are able to secrete acids to dissolve rock, helping in weathering and soil formation. Xerarch is ecological succession in dry areas. As a result of succession, forests are established as climax community. Hydrach is the succession in water and it starts with phytoplanktons, goes through submerged plants, submerged free floating plants, reed swamp stage, marsh meadow stage, scrub stage to forest stage as climax community.

26. **(b) :** According to an estimate, a substantial fall in CO_2 and SO_2 level has been found in Delhi between 1997 and 2005.

27. **(b) :** Natality and immigration positively contribute to the population growth while mortality and emigration are negative factors. In the given question,
The net increase in population is natality + immigration $= 250 + 20 = 270$
The net decrease in population is mortality + emigration $= 240 + 30 = 270$
Thus, net increase in population $= 270 - 270 = 0$

28. **(a)**

29. **(c) :** The network of the interconnected food chains at a different trophic level in a biotic community is termed as food web. Kite, a bird which can also be a part of food web.

30. **(c)**

31. **(d) :** Metals like copper, iron, silicon, nickel and gold are recovered during recycling process of e-wastes.

32. **(c) :** Microorganisms play an important role in ecosystem. N_2-fixing organisms such as bacteria and cyanobacteria convert atmospheric nitrogen into nitrogenous compounds by the process of biological N_2-fixation. Decomposer organisms ***e.g.*** some bacteria and fungi break down complex organic matter into inorganic substances by the process of decomposition.

33. **(d) :** Eagle is a top carnivore and can occupy both third and fourth trophic levels in a food chain.

34. **(b) :** Desert lizard bask in the sun and absorb heat when their body temperature drops below the comfort zone but move into shade when ambient temperature starts increasing.

35. **(b) :** Nuclear reactor malfunction may result in radioactive pollution by which water, air and soil gets polluted. This may prove harmful not only for the present generation but also for future generations. Moderate or high levels of radioactivity can damage or kill organisms as well as cause diseases such as cancer.

36. **(a) :** Light is an important abiotic factor for both plants and animals as well. Many animals use the diurnal and seasonal variations in light intensity and duration as cues for timing their foraging, reproductive and migratory activities.

37. **(b)**

38. **(a) :** Food chain is the linear sequence of organisms where latter eats the former. There are two types of food chains: grazing food chain (GFC) and detritus food chain (DFC). GFC starts with green plants as producers and ends at secondary carnivores. The DFC begins with dead organic matter and is made up of decomposers which meet their energy and nutrient requirements by degrading dead organic matter or detritus. In an aquatic ecosystem GFC is the major conduit for energy flow, while in a terrestrial ecosystem, a much larger fraction of energy flows through DFC than through the GFC.

39. **(d) :** Genetic diversity means diversity at genomic level whereas diversity at species level is termed as species diversity. Western ghats have greater amphibian species diversity than eastern ghats.

40. **(d)** 41. **(d)**

42. **(b) :** X is grazing food chain, Y is detritus food chain.

43. **(d) :** Primary consumer (earthworm) is detritivore which feeds upon the dead and decaying organic matter and will convert it into inorganic substances used by the another plant. Thus, a detritus food chain also allows nutrient cycling.

44. **(a)**

45. **(d) :** Food chain X will form upright pyramid of energy. Falcon can be considered as top carnivore.

46. **(a)** 47. **(c)**

48. **(a) :** Sigmoid growth curve called Verhulst-Pearl Logistic growth is described by the following equation:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

49. **(a)** 50. **(d)**

☺☺

GK CORNER

Enhance Your General Knowledge with Current Updates!

e-rupee (e₹)

- India launches digital rupee pilot project-The Reserve Bank of India (RBI) on 1st December 2022 launched the Central Bank Digital Currency (CBDC) — digital rupee or e-rupee (e₹) — for the common man. The pilot will initially cover the four cities of **Mumbai, New Delhi, Bengaluru,** and **Bhubaneswar.**

  It is a legal tender issued by the RBI in digital form. It is the same as the fiat currency and is exchangeable one-to-one with the fiat currency.

  e-rupee will be in the form of a digital token representing a claim on the central bank and will effectively function as the digital equivalent of a banknote that can be transferred electronically from one holder to another.

SCHEMES

- Ministry of Power has launched a scheme for procurement of aggregate power of 4500 MW for five years under **SHAKTI Policy**. The scheme will help states that are facing power shortage and help generation plants to increase their capacities.
- The Ministry of New and Renewable Energy (MNRE), Government of India has notified the National Bioenergy Programme on November 2, 2022. MNRE has continued the **National Bioenergy Programme** for the period from FY 2021-22 to 2025-26. The Programme has been recommended for implementation in two Phases. The Phase-I of the Programme has been approved with a budget outlay of Rs. 858 crore.
- Recently, the Ministry of Rural Development launches the **"Nai Chetna-Pahal Badlav Ki"- A Community-led National Campaign Against Gender-Based Discrimination.** It is a four-week campaign in Kerala, aiming at equipping women to recognise and prevent violence and making them aware of their rights.
- The Bihar Chief Minister Nitish Kumar on 27th November 2022 launched the **Har Ghar Gangajal project** in Rajgir to deliver water from Ganga river to the dry areas in the state that do not lie along the course of the river.
- The **Sanitation Workers' Development Scheme** was launched by the Tamil Nadu Chief Minister M K Stalin on 9th December 2022 to identify conservancy workers and ensure their welfare through various government initiatives.
- Rekha Sharma , the chairperson of National Commission for Women (NCW) launched **Digital Shakti campaign 4.0**, a pan-India project for digitally skilling and empowering girls and women in cyberspace on 15th November 2022. The NCW launched it in collaboration with Meta and Cyber Peace Foundation.
- **Rooftop Solar Programme Phase-II** has been implemented wherein subsidy is being provided to residential consumers for installation of rooftop solar. Central Government announced that it has extended the Rooftop Solar Programme till 31st March, 2026.
- The **Nirogi Haryana Project** was launched on 29th November to provide comprehensive free health check-ups and required medical treatment to beneficiary families. The initial phase of this scheme was launched in District Hospital, Sector 6, Panchkula.

MISSIONS

- Atal Innovation Mission (AIM), NITI Aayog has launched Woman centric challenges under phase-II of the 2nd edition of the Atal New India Challenge (ANIC). ANIC is an initiative by AIM, NITI Aayog targeted to seek, select, support and nurture technology-based innovations that solve sectoral

- challenges of national importance and societal relevance.
- Tamil Nadu Chief Minister M.K. Stalin launched the **Tamil Nadu Climate Change Mission** on 9th December 2022 to protect the natural resources in the state besides restore them on a long-term basis. The objective of the mission is to make Tamil Nadu a "climate smart state". It also seeks to create smarter infrastructure systems to minimise disasters and respond to them effectively.

Test Yourself!

1. Which scheme was started recently in Haryana to provide free health check ups?
(a) Nirogi Haryana Project
(b) Janani Surakha Yojna
(c) Janani Shishu Suraksha Karyakran
(d) Arogya Sanjeevani Scheme

2. Which phase of "Digital Shakti" launched by National Commission for Women in November 2022?
(a) Second (b) Third
(c) Fourth (d) Fifth

3. Who launched Tamil Nadu climate change mission?
(a) Jagan Mohan Reddy (b) Basavaraj Bomai
(c) Pinarayi Vijayan (d) M.K. Stalin

4. The Sanitation Workers' Development scheme is launched by which state?
(a) Maharashtra (b) Tamil Nadu
(c) Andhra Pradesh (d) Kerala

5. "Har Ghar Gangajal" scheme is launched in which state?
(a) Madhya Pradesh (b) Bihar
(c) Punjab (d) Haryana

6. When did "National Bio Energy Programme" launch?
(a) November 7,2022 (b) November 12,2022
(c) November 28,2022 (d) November 2,2022

7. The objective of _____ scheme of Niti Aayog is to promote the culture of innovation and entrepreneurship in the country?
(a) Sehkari Samiti (b) Atal Innovation Mission
(c) Jan Andolan (d) Start-up India

8. "Shakti Policy" is related to which concept?
(a) Power supply
(b) Forest protection
(c) Women empowerment
(d) Space mission

9. The Rooftop Solar Programme which aims on promoting the renewable energy resources launched by central government is extended till which date?
(a) 30 April 2023 (b) 31 March 2026
(c) 30 June 2023 (d) 31 January 2026

10. Which Ministry has launched "Nai Chetna" Campaign?
(a) Ministry of Women
(b) Ministry of AYUSH
(c) Ministry of Rural Development
(d) Ministry of Agriculture and Farmers Welfare

Answer Key

1. (a) **2.** (c) **3.** (d) **4.** (b) **5.** (b)
6. (d) **7.** (b) **8.** (a) **9.** (b) **10.** (c)

⁂

Biology bulletin

A "Game Changing" Chapter in the History of Evolution

Two-million-years-old DNA has been identified for the first time that opens a new chapter in the history of evolution.

A team of scientists led by Professor Eske Willerslev (University of Cambridge) and Professor Kurt Kjær (University of Copenhagen) discovered microscopic fragments of environmental DNA in Ice Age sediment in Northern Greenland. Using cutting-edge technology, all hidden in clay and quartz, researchers discovered that the fragments are one million years older than the DNA sampled from a Siberian mammoth bone.

The ancient DNA has been used to map a two million-year-old ecosystem which weathered extreme climate change. Researchers hoped that the results could help predict the long-term environmental toll of today's global warming. Evidence of animals, plants and microorganisms, including reindeer, hares, lemmings, birch and poplar trees was discovered.

According to, Prof Kjær, "the ancient DNA samples were found buried deep in sediment that had built up over 20,000 years. The sediment was eventually preserved in ice or permafrost and, crucially, not disturbed by humans for two million years."

Are you ready for Olympiads?

LEVEL 2

Exam on 12th February 2023

SOF SCIENCE OLYMPIAD FOUNDATION | NSO SOF NATIONAL SCIENCE OLYMPIAD

CLASS XI

SYLLABUS*

Section – 1 : *Physics* : Units and Measurements, Mechanics, Properties of Matter, Heat and Thermodynamics, Oscillations, Waves.

Chemistry : Some Basic Concepts of Chemistry, Structure of Atom, Classification of Elements and Periodicity in Properties, Chemical Bonding and Molecular Structure, States of Matter, Thermodynamics, Equilibrium, Redox Reactions, Hydrogen, The *s*-Block Elements, The *p*-Block Elements (Groups 13 and 14), Organic Chemistry - Some Basic Principles and Techniques, Hydrocarbons, Environmental Chemistry.

Section – 2 : Higher Order Thinking Questions - Syllabus as per Section – 1.

Section – 3 : Sets, Relations and Functions, Principle of Mathematical Induction, Logarithms, Complex Numbers & Quadratic Equations, Linear Inequations, Sequences and Series, Trigonometry, Straight Lines, Conic Sections, Permutations and Combinations, Binomial Theorem, Statistics, Mathematical Reasoning, Limits and Derivatives, Probability, Introduction to 3-D Geometry.

OR

Section – 3 : Diversity in the Living World, Structural Organisation in Plants and Animals, Cell : Structure and Functions, Plant Physiology, Human Physiology.

Total Questions : 50 Time : 1 hr.

PATTERN & MARKING SCHEME

Section	(1) Physics & Chemistry	(2) Achievers Section	(3) Mathematics or Biology
No. of Questions	25	5	20
Marks per Ques.	1	3	1

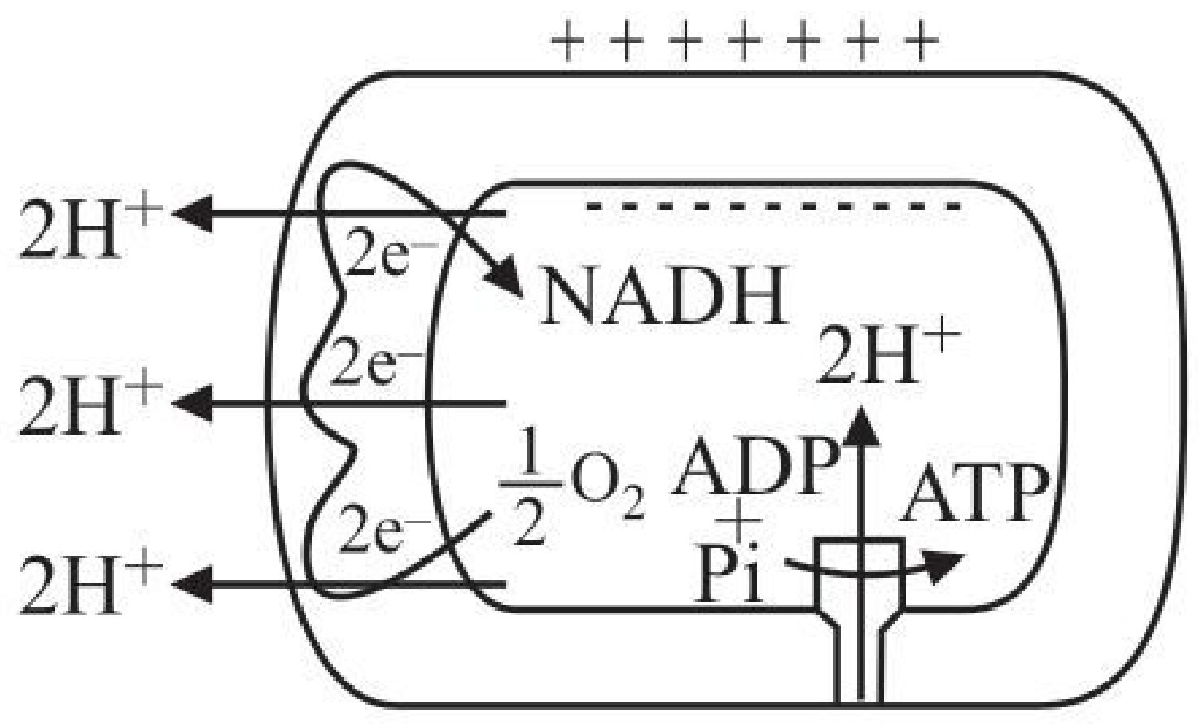
Practice Questions

1. Match the column I with column II.

	Column I		Column II
(P)	Gibberellins	(i)	Kinetin
(Q)	Cytokinins	(ii)	Dormin
(R)	Ethylene	(iii)	Apical dominance
(S)	Auxins	(iv)	*Gibberella fujikuroi*
(T)	Abscisic acid	(v)	Ethephon
		(vi)	IBA
		(vii)	Cytokinesis
		(viii)	Stress hormone
		(ix)	Bolting
		(x)	Climacteric ripening

	P	Q	R	S	T
A.	(iv, ix)	(i, vii)	(v, x)	(ii, vi)	(iii, viii)
B.	(iv, ix)	(i, vii)	(v, x)	(iii, vi)	(ii, viii)
C.	(iv, x)	(ii, vii)	(v, i)	(iii, vi)	(ix, viii)
D.	(iv, ix)	(i, vii)	(v, ii)	(iii, vi)	(x, viii)

2. Mechanism of phosphorylation is depicted in the given diagram. Study it carefully and select the correct option.



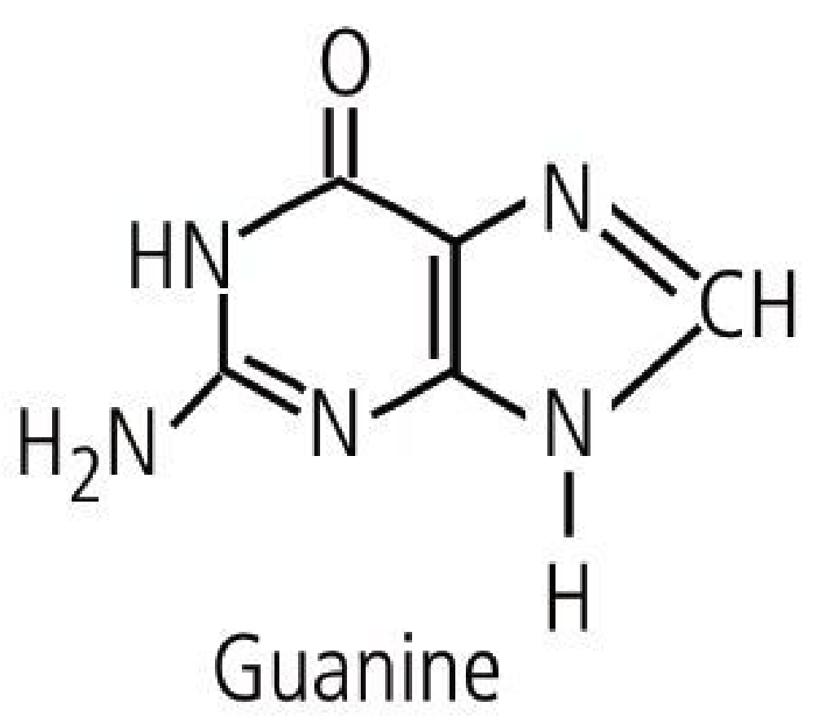
A. The diagram depicts photosynthetic phosphorylation taking place in the chloroplast. The incident light should be shown in the diagram.

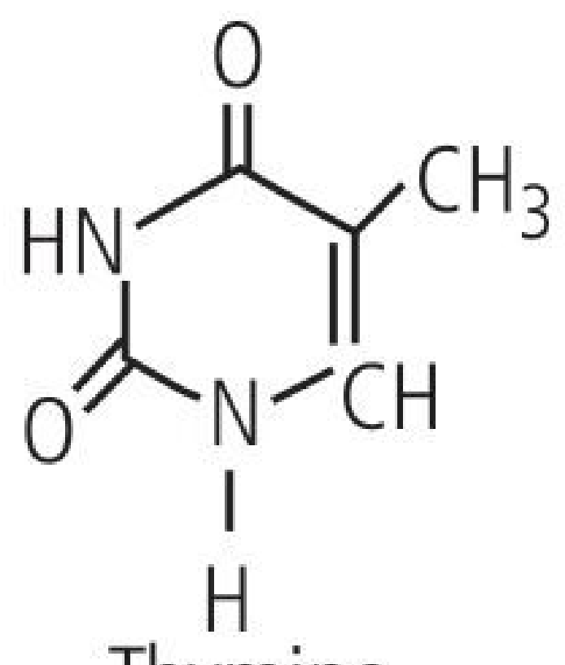
B. The diagram depicts oxidative phosphorylation taking place in mitochondria. However, the flow of electrons should be shown in reverse direction.

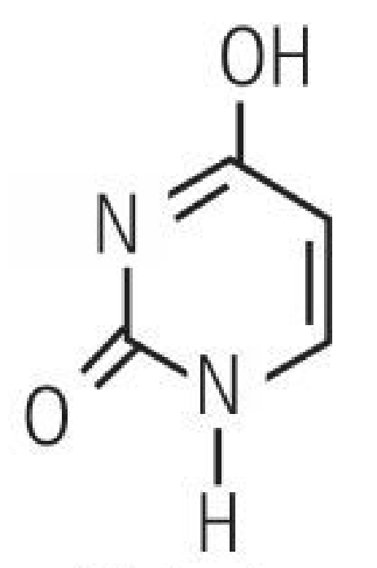
C. Diagram depicts the basic process of both oxidative as well as photosynthetic phosphorylation. However, the proton concentration should be high inside and low outside.

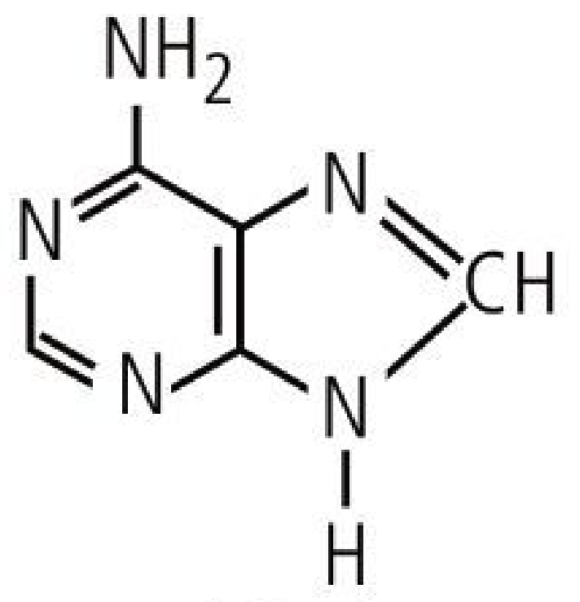
D. None of these

3. Given below are four structures of nitrogenous bases. Identify the incorrect one.

A.

Guanine

B.

Thymine

C.

Cytosine

D.

Adenine

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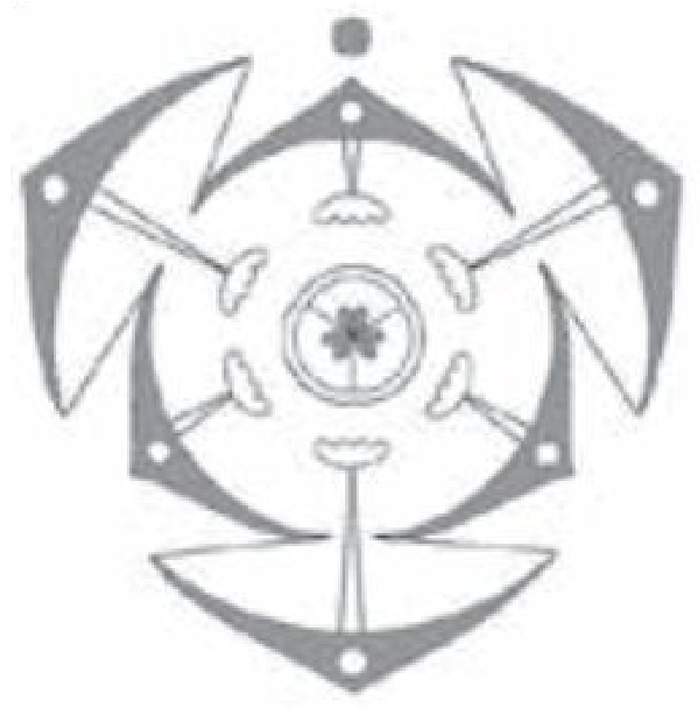
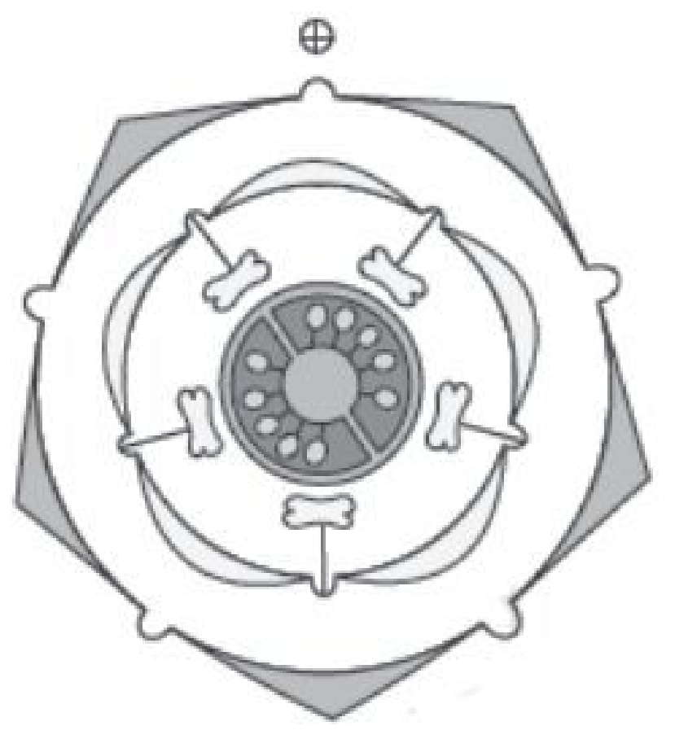
4. Refer to the given floral diagrams, X and Y and select the correct option.


X


Y

(i) X belongs to dicot family whereas Y belongs to monocot family.

(ii) Floral formula of X is Br ⊕⚥ $\overset{\frown}{P_{(3+3)}A}_{3+3}\underline{G}_{(3)}$ and of Y is ⊕⚥ $K_{(5)}\overset{\frown}{C_{(5)}A}_{5}\underline{G}_{(2)}$

(iii) Flowers with X and Y floral diagrams have 6 stamens with tetradynamous condition.

(iv) X has tricarpellary syncarpous gynoecium whereas Y has bicarpellary syncarpous gynoecium.

(v) X and Y type of floral diagrams are found in *Asparagus* and *Petunia* respectively.

(vi) In both, X and Y, perianth is arranged in two whorls, outer sepals are free in both whereas inner petals show twisted aestivation in X and imbricate aestivation in Y.

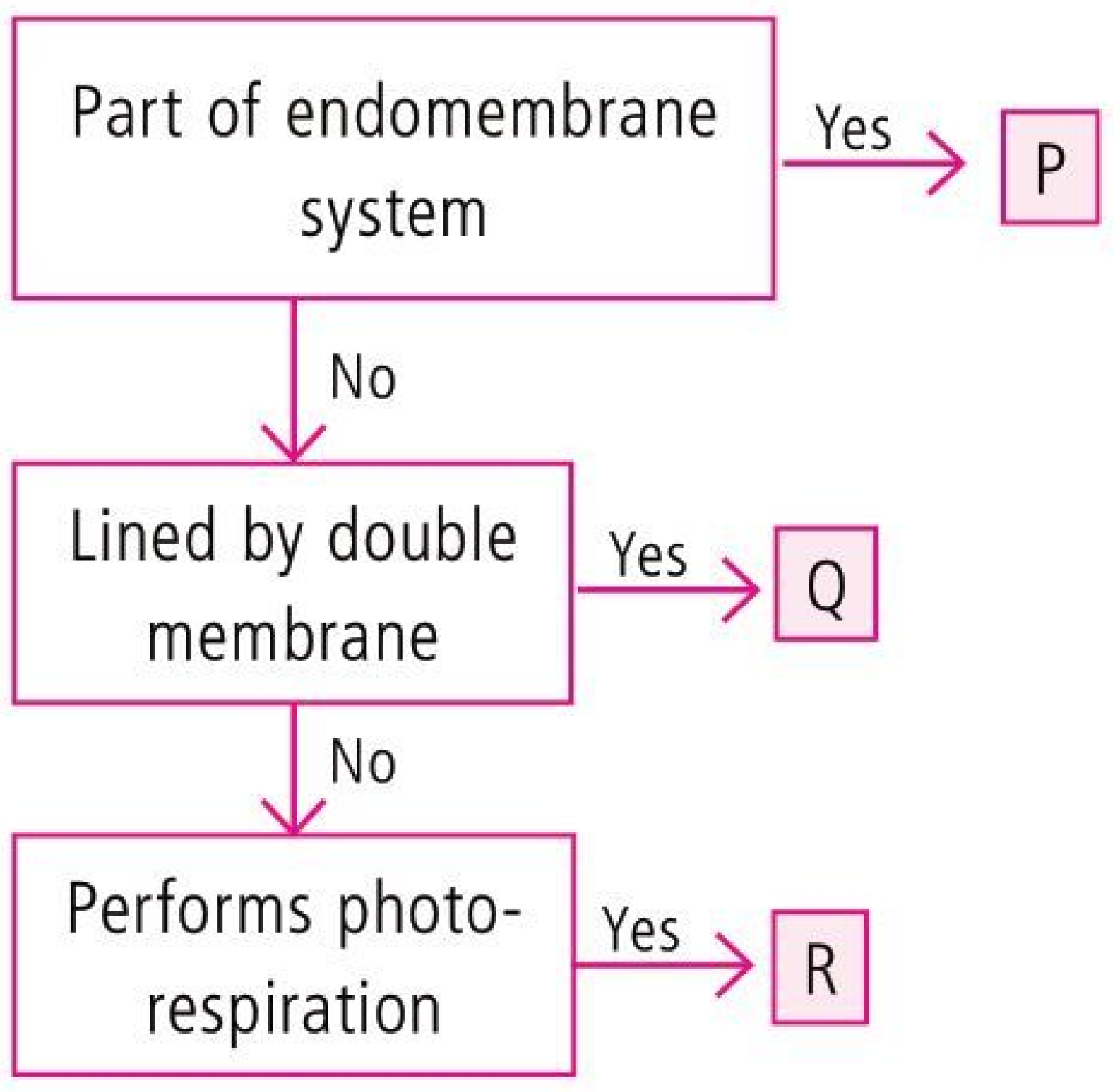
A. (ii), (iv) and (v) only B. (i), (ii) and (iii) only
C. (iv), (v) and (vi) only D. (ii), (v) and (vi) only

5. Match the following and choose the correct option.

Types of synovial joints	**Bones involved**
(P) Ball and socket	1. Carpal and metacarpal of thumb
(Q) Hinge	2. Atlas and axis
(R) Pivot	3. Frontal and parietal
(S) Saddle	4. Knee
	5. Humerus and pectoral girdle

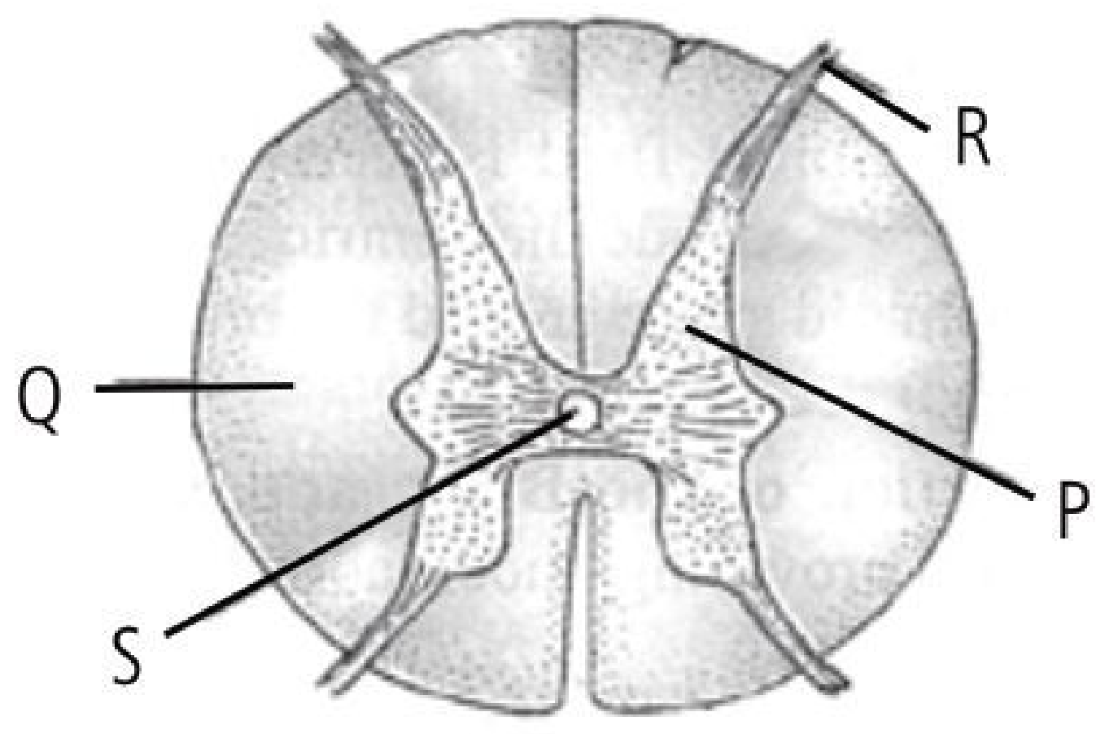
A. (P) - 5, (Q) - 4, (R) - 2, (S) - 1
B. (P) - 1, (Q) - 3, (R) - 4, (S) - 5
C. (P) - 5, (Q) - 4, (R) - 3, (S) - 1
D. (P) - 1, (Q) - 2, (R) - 5, (S) - 4

6. Refer to the given flow chart regarding different cell organelles and select the incorrect statement(s) regarding P-R.



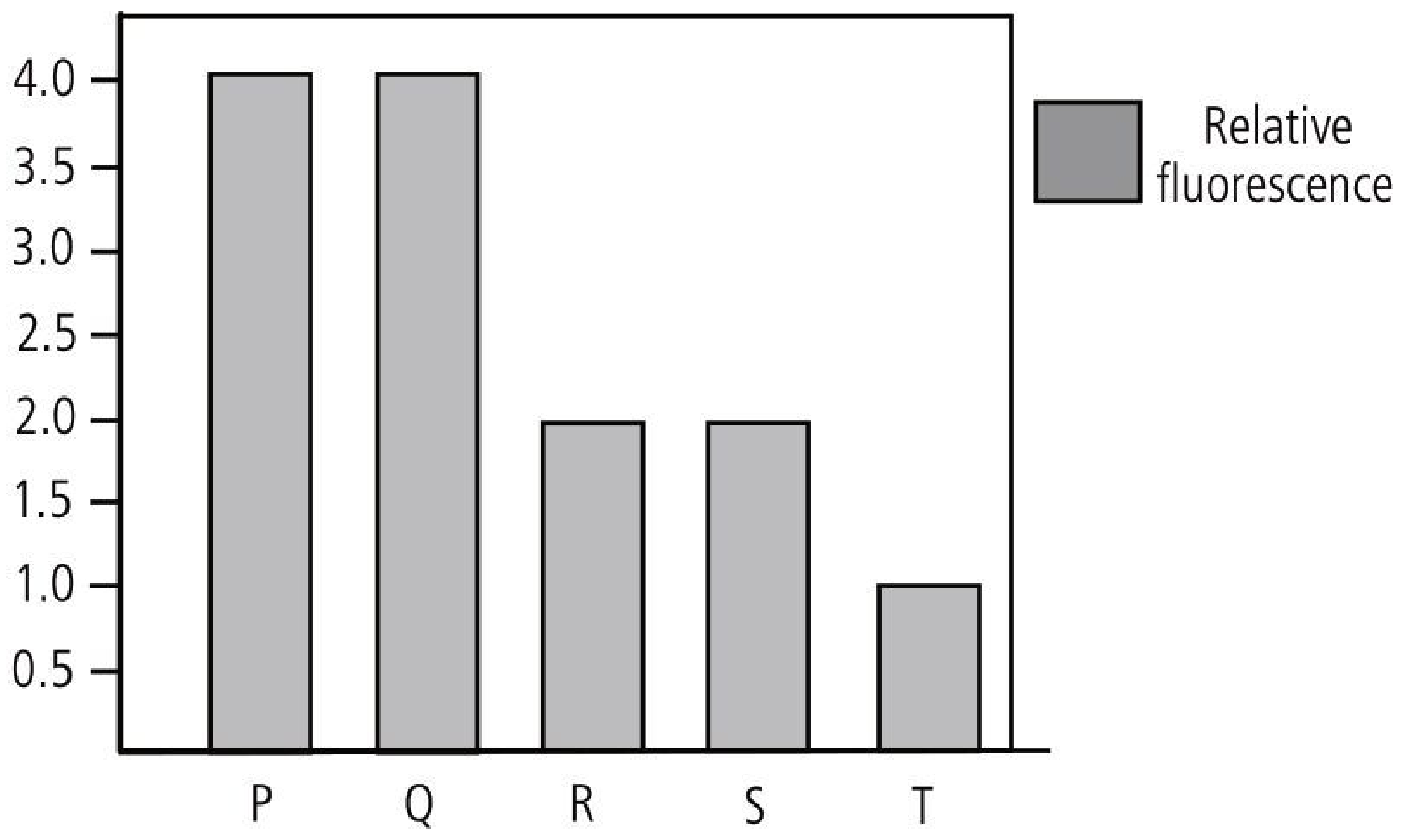
A. P could be an organelle that helps to maintain proper osmotic pressure in the cell.
B. Q could be an organelle that secretes enzymes which are used for breaking limiting membrane of eggs.
C. R could be an organelle that metabolises in number of toxic substances like nitrite, phenols, etc.
D. Both (B) and (C)

7. Study the given figure and select the correct statement.



A. P - is grey in colour due to presence of myelin
B. Q - is located deep into the core of spinal cord
C. R - contains sensory axons
D. S - contains motor axons

8. The amount of DNA in a cell can be determined by measuring the fluorescence of a dye that binds in direct proportion to the amount of DNA. The graph below represents the fluorescence of a eukaryotic germ cell during different stages of cell division.



Which of the following options represents the correct match of bars (*P* – *T*) with the division stages (numbered i - v) given below?

(i) Anaphase I of meiosis
(ii) Anaphase II of meiosis
(iii) Cytokinesis following telophase II
(iv) Prophase II of meiosis
(v) Prophase I of meiosis

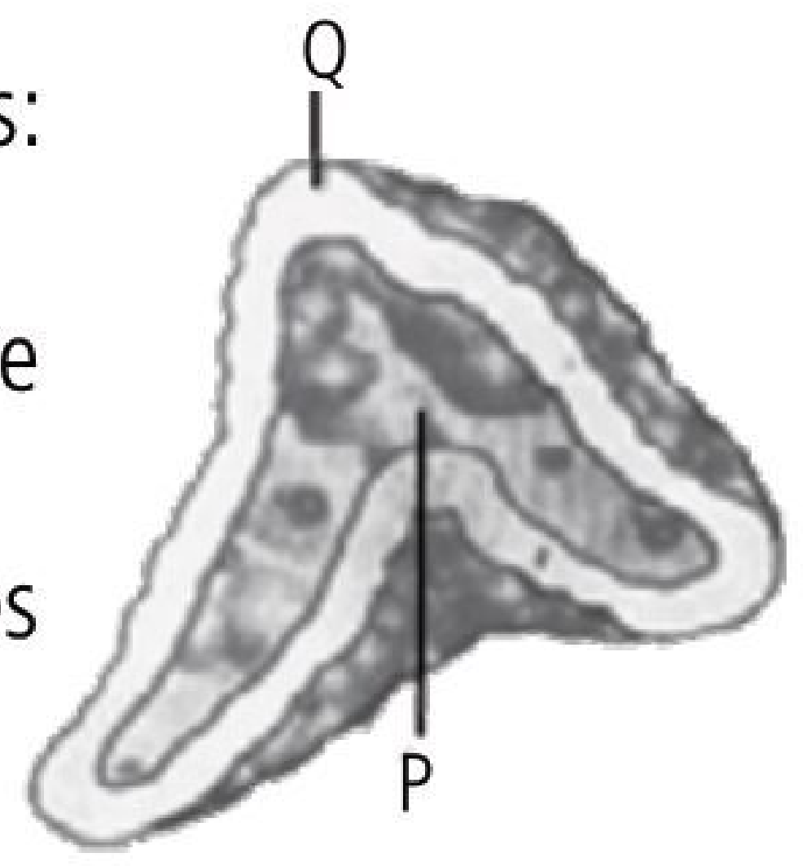
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**
A.	Q	T	R	S	P
B.	R	S	T	P	Q
C.	Q	S	T	R	P
D.	S	P	Q	R	T

9. Select true statements from the following and choose the right answer from the options given below.

I. Human's scientific name is *Homo sapiens*.
II. Lower the taxa, lesser are the characteristics that the members within the taxon share.
III. Division is the highest taxonomic category.
IV. Taxonomic group of any rank is taxon.
V. A group of closely related species of organism represent genus.
VI. The term 'new systematics' was coined by de Candolle.

A. II, III, IV and VI B. I, III, V and VI
C. I, IV and V D. II, III and VI

10. Find the incorrect statement regarding labelled parts in the given figure.



A. The part 'P' secretes two hormones: adrenaline and nor-adrenaline.
B. The part 'Q' is divided into three layers.
C. The part 'Q' secretes hormones called as corticoids.
D. None of these

11. Which of the following is true for the labels 1 to 4 of the given figure?

A. 4 – 'Gills' help in exchange of gases
B. 3 – Annulus, outgrowth of pileus for assisting in spore dispersal
C. 2 – Stipe, edible part rich in protein and formed of secondary mycelium
D. 1 – Primary mycelium produced by germination of teleutospore

12. The given representation shows the relationship between various metabolic processes.

$$\begin{tikzcd} & \text{Glucose} \arrow[d, "P"] & \\ \text{CO}_2 + \text{H}_2\text{O} & \text{Pyruvate} \arrow[l, "Q"'] \arrow[r, "R"'] & \text{Lactate} \end{tikzcd}$$

Which of the following statements are correct regarding this?

(i) Acetyl coenzyme A is required for step Q.
(ii) Substrate level phosphorylation occurs in both steps P and Q.
(iii) There is a net loss of ATP during steps P, Q and R.
(iv) Oxidised form of NAD is used in steps P and R.

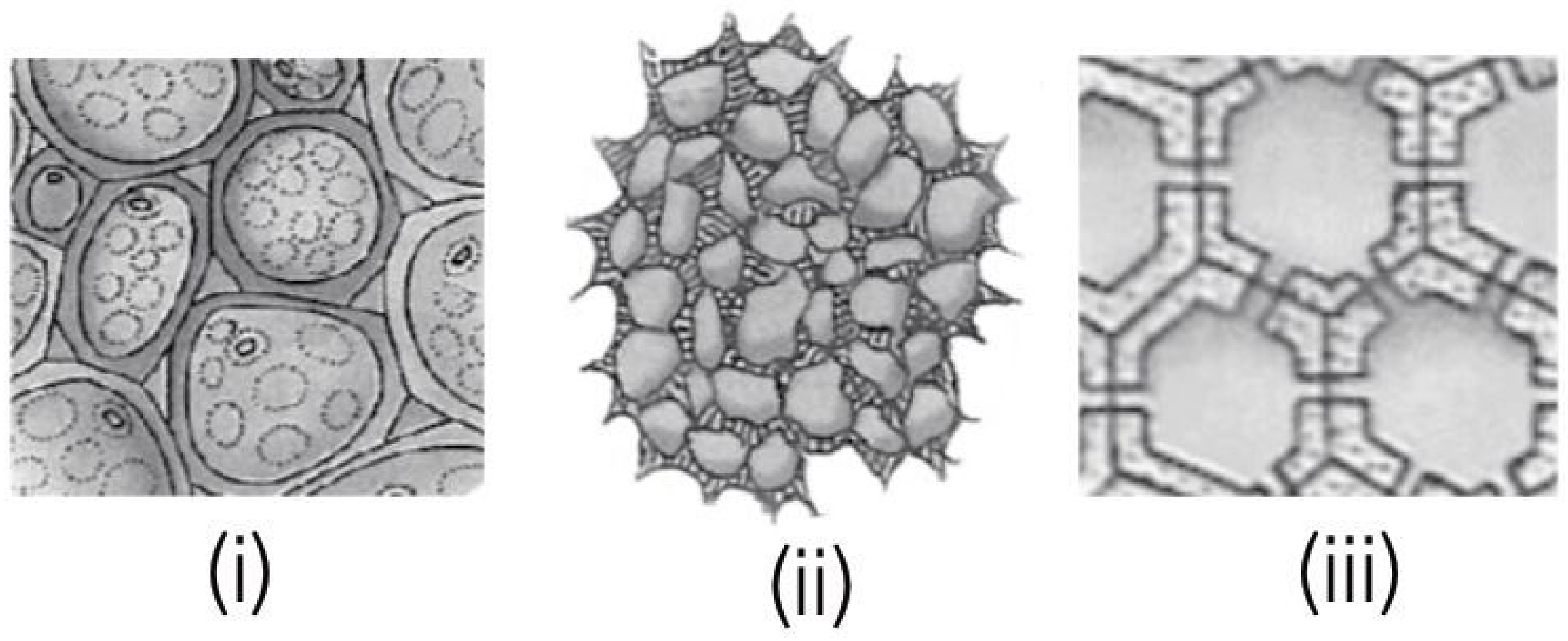
A. (i) and (ii) only B. (i) and (iii) only
C. (ii) and (iv) only D. (i), (ii) and (iv) only

13. Match column I with column II and select the correct option from the codes given below.

Column I	**Column II**
(P) Alginic acid	(i) *Rhodomela*
(Q) Bromine	(ii) *Gracilaria*
(R) Agar	(iii) *Chlamydomonas*
(S) Sewage oxidation	(iv) *Polysiphonia*
	(v) *Gelidium*
	(vi) *Laminaria*
	(vii) *Scenedesmus*
	(viii) *Sargassum*

A. (P)-(ii, v), (Q)-(iii, iv), (R)-(i, viii), (S)-(vi, vii)
B. (P)-(vi, viii), (Q)-(i, iv), (R)-(ii, v), (S)-(iii, vii)
C. (P)-(vi, iii), (Q)-(ii, v), (R)-(i, viii), (S)-(iv, vii)
D. (P)-(vi, viii), (Q)-(vii, iv), (R)-(ii, v), (S)-(i, iii)

14. Observe the given figures of three different plant tissues and select the correct option.



A. (i) and (ii) consist of living cells while (iii) consists of dead cells.
B. Cytoplasm is present in cells of (i) while it is absent in cells of (ii) and (iii).
C. Cell walls of (i), (ii) and (iii) bear uniform thickening of suberin.
D. (i) provides mechanical strength to the plant while (ii) and (iii) serve as storage tissues.

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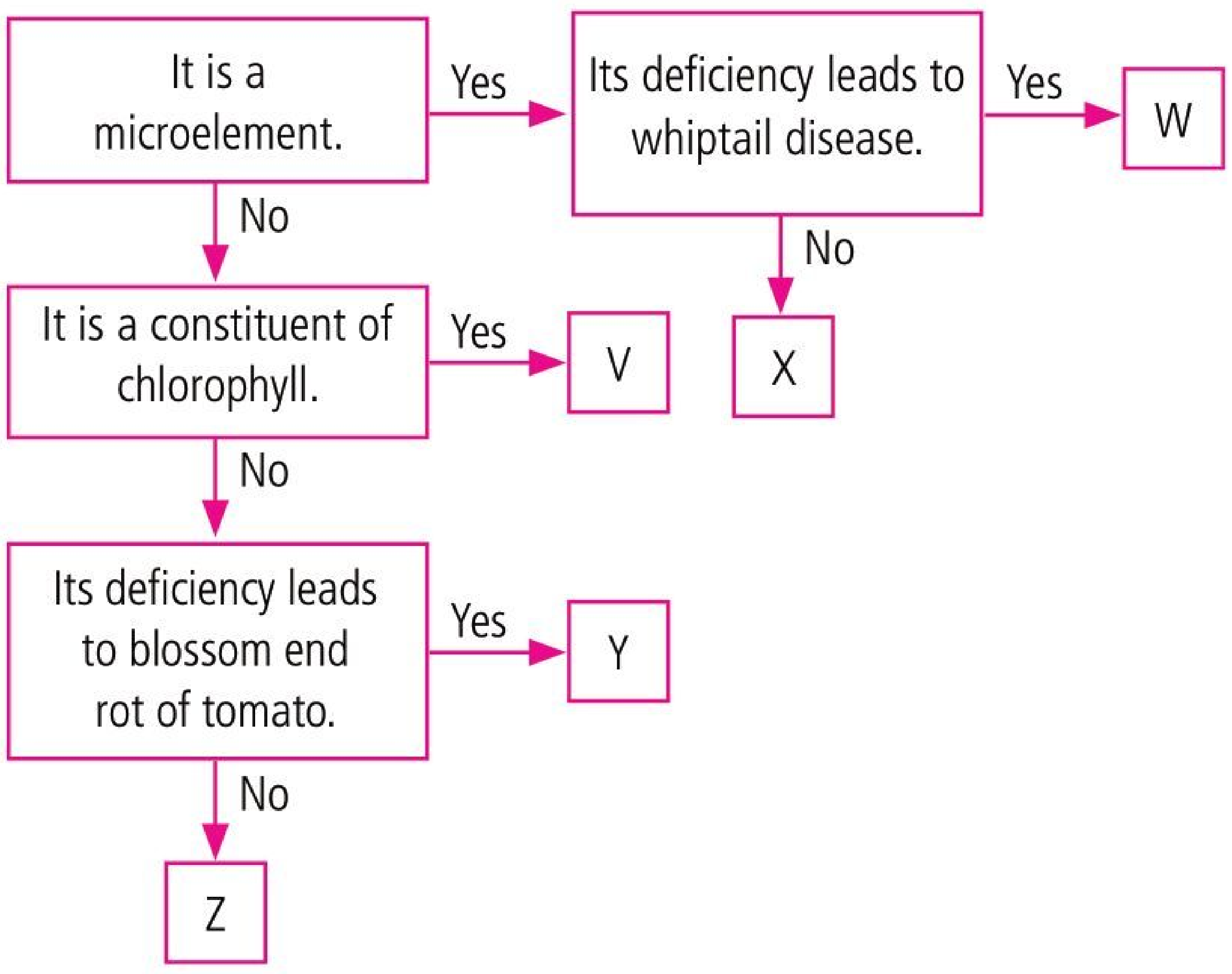
15. Study the given flow chart and select the correct option.


It is a microelement.
Yes
Its deficiency leads to whiptail disease.
Yes
W
No
No
It is a constituent of chlorophyll.
Yes
V
X
No
Its deficiency leads to blossom end rot of tomato.
Yes
Y
No
Z

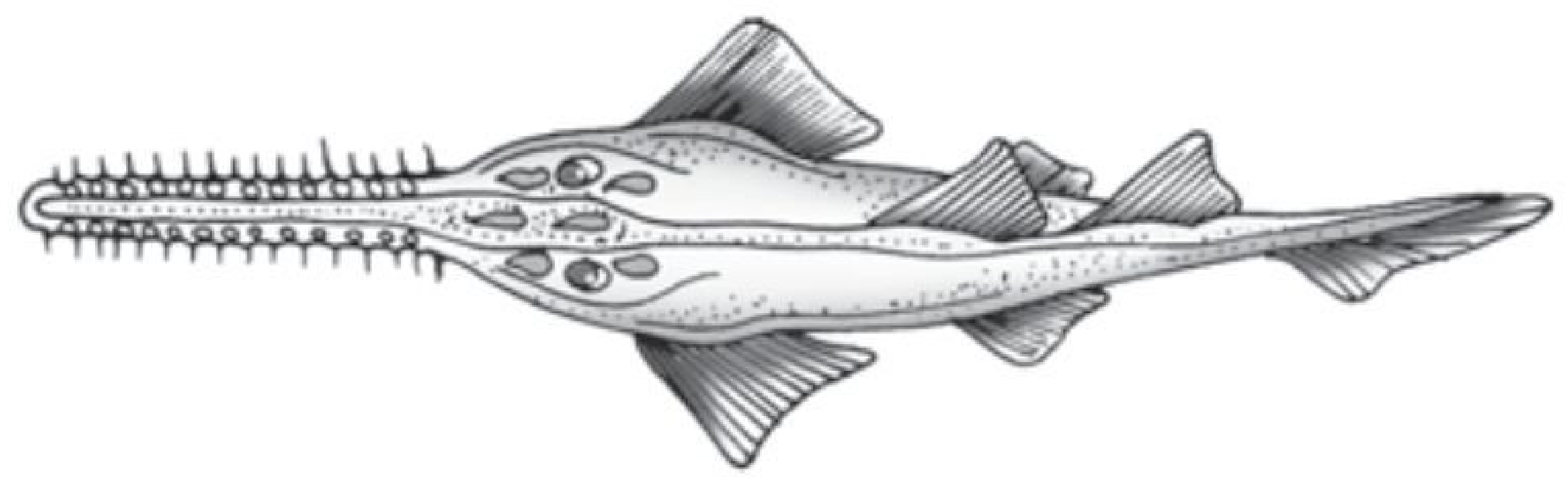
	V	W	X	Y	Z
A.	Magnesium	Molybdenum	Iron	Calcium	Phosphorus
B.	Magnesium	Iron	Molybdenum	Phosphorus	Calcium
C.	Calcium	Molybdenum	Iron	Magnesium	Phosphorus
D.	Phosphorus	Calcium	Iron	Molybdenum	Magnesium

16. Refer to the given table showing differences between arteries and veins and select the incorrect differences.

	Arteries	Veins
(i)	Tunica media is thick, having more muscle fibres.	Tunica media is thin, having fewer muscle fibres.
(ii)	Tunica interna has strong elastic membrane and more elongated endothelial cells.	Tunica interna has simple, elastic membrane and elongated endothelial cells.
(iii)	They are collapsible.	They are not collapsible.
(iv)	They have no valves.	They have valves which prevent backward flow of blood.
(v)	The flow of blood is not so fast because the blood is under low pressure.	The flow of the blood is fast as the blood in them is under great pressure.

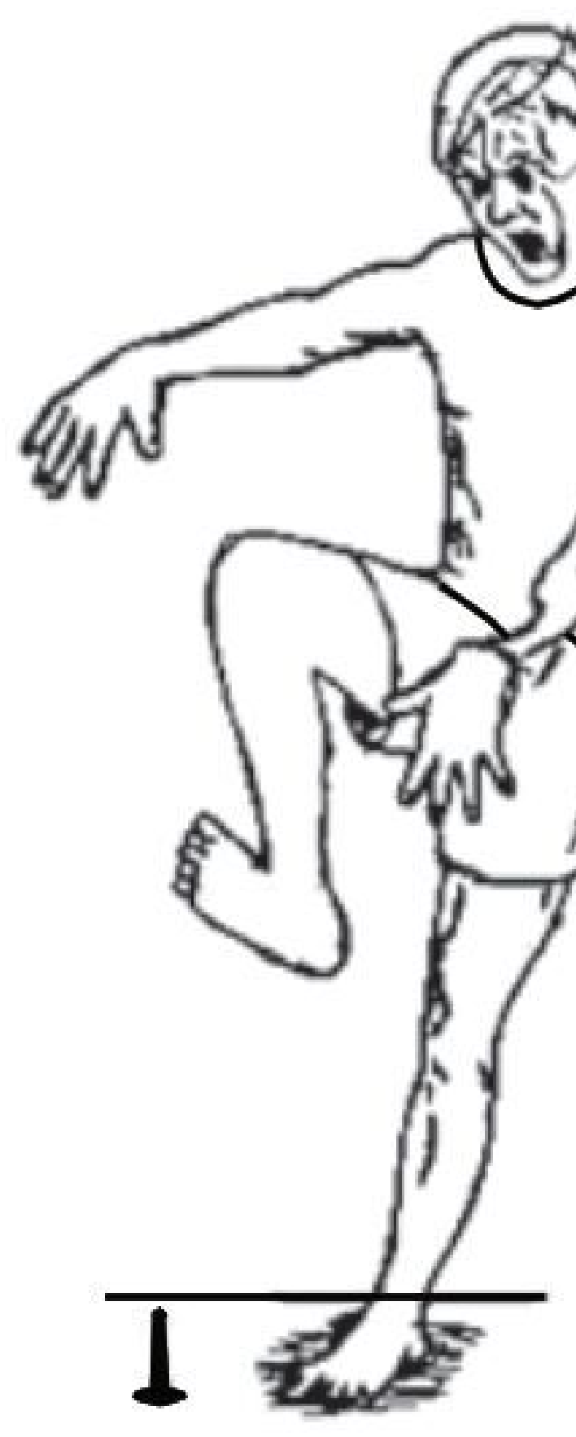
A. (iii) and (v) only B. (i), (ii) and (iv) only
C. (i), (iii) and (iv) only D. (ii) and (v) only

17. Identify the animal which is given and choose the correct statement for it.



A. The animal belongs to Class Chondrichthyes and these do not have to swim constantly to avoid sinking.
B. The animal belongs to Class Osteichthyes and these animals have cycloid/ctenoid scales.
C. The animal belongs to Class Chondrichthyes and these animals have cartilaginous endoskeleton and notochord is persistent throughout life.
D. The animal belongs to Class Osteichthyes and in these animals vertebral column is absent but notochord persists throughout life.

18. The given figure shows a man experiencing a sudden withdrawal of the leg that got in contact with a pointed object. Which of the following nervous pathways gives such response?



A. Receptor → Efferent nerve fibre → Grey matter of spinal cord → Afferent nerve fibre → Effector
B. Receptor → Afferent nerve fibre → Grey matter of spinal cord → Efferent nerve fibre → Effector
C. Effector → Afferent nerve fibre → White matter of spinal cord → Efferent nerve fibre → Receptor
D. Receptor → Efferent nerve fibre → White matter of spinal cord → Afferent nerve fibre → Effector

19. Consider the following statements and select the option that correctly identifies the true (T) and false (F) ones.
(i) Bone forming cells, osteoblasts produces new bone material.
(ii) Bone matrix is composed of a protein called ossein.

(iii) Yellow elastic cartilage is the strongest cartilage in the body.

(iv) Blood vessels are usually absent in epithelial tissues.

	(i)	(ii)	(iii)	(iv)
A.	F	T	T	F
B.	T	T	F	T
C.	F	T	T	F
D.	T	F	F	T

20. A man is admitted to a hospital. He is suffering from an abnormally low body temperature, loss of appetite and extreme thirst. His brain scan would probably show a tumour in

A. cerebellum

B. hypothalamus

C. medulla oblongata

D. pons.

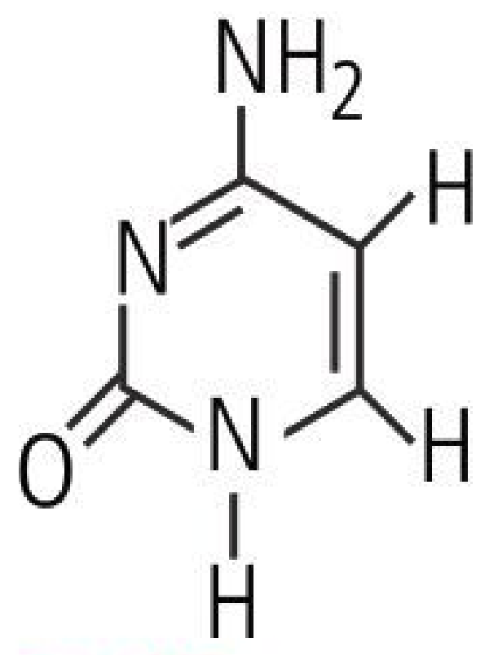
Darken your choice with HB Pencil

1.	Ⓐ Ⓑ Ⓒ Ⓓ	**5.**	Ⓐ Ⓑ Ⓒ Ⓓ	**9.**	Ⓐ Ⓑ Ⓒ Ⓓ	**13.**	Ⓐ Ⓑ Ⓒ Ⓓ	**17.**	Ⓐ Ⓑ Ⓒ Ⓓ
2.	Ⓐ Ⓑ Ⓒ Ⓓ	**6.**	Ⓐ Ⓑ Ⓒ Ⓓ	**10.**	Ⓐ Ⓑ Ⓒ Ⓓ	**14.**	Ⓐ Ⓑ Ⓒ Ⓓ	**18.**	Ⓐ Ⓑ Ⓒ Ⓓ
3.	Ⓐ Ⓑ Ⓒ Ⓓ	**7.**	Ⓐ Ⓑ Ⓒ Ⓓ	**11.**	Ⓐ Ⓑ Ⓒ Ⓓ	**15.**	Ⓐ Ⓑ Ⓒ Ⓓ	**19.**	Ⓐ Ⓑ Ⓒ Ⓓ
4.	Ⓐ Ⓑ Ⓒ Ⓓ	**8.**	Ⓐ Ⓑ Ⓒ Ⓓ	**12.**	Ⓐ Ⓑ Ⓒ Ⓓ	**16.**	Ⓐ Ⓑ Ⓒ Ⓓ	**20.**	Ⓐ Ⓑ Ⓒ Ⓓ

SOLUTIONS

1. (B) **2. (B)**

3. (C) : The structure of cytosine is as follows:



4. (A) **5. (A)** **6. (B)**

7. (C) : In the given figure P-Grey matter, Q-White matter, R-Posterior root of spinal nerve, S-Central canal. Grey matter is so named because it lacks myelin and, therefore appears grey in an unstained preparation. Grey matter is located deep into the core of spinal cord. The hollow central canal contains cerebrospinal fluid.

8. (C)

9. (C) : Lower the taxa, more are the characteristics that the members within the taxon share. Highest taxonomic category is kingdom in taxonomic hierarchy. Term 'New Systematics' was first time used by Julian Huxley.

10. (D)

11. (C) : Label 1 is hypha producing fruiting body, it is dikaryotic; Label-2 stipe is edible, formed of secondary mycelium; Label-3 annulus is remains of velum which protects young developing gills; Label 4 gills help in production of basidiospores from its hymenium part.

12. (A) **13. (B)**

14. (A) : Figures (i) and (ii) represent parenchymatous and collenchymatous tissues, respectively that are living tissues. Figure (iii) represents sclerenchymatous tissue which comprises of dead cells.

15. (A)

16. (A) : Arteries are not collapsible as they have thick walls whereas veins are collapsible because they have thin walls. The flow of blood is fast in arteries as the blood in them is under great pressure whereas the flow of blood in veins is not so fast because the blood in veins is under low pressure.

17. (C)

18. (B) : The withdrawal reflex is a spinal reflex intended to protect the body from damaging stimuli when a body suddenly comes in contact with the pointed objects, the receptors are stimulated and pass information to the afferent nerve fiber, which in twin goes to the grey matter of spinal cord then to afferent nerve fiber and finally to the effector.

19. (B) : White fibrous cartilage is the strongest cartilage in the body.

20. (B)

For other sections/subjects please refer to Physics For You and Chemistry Today

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CLASS XII

SYLLABUS*

Section – 1 : *Physics* : Electricity and Magnetism, Electromagnetic Induction, Alternating current, Electromagnetic waves, Optics, Modern Physics, Semiconductor Electronics, Communication Systems.

Chemistry : Solid State, Solutions, Electrochemistry, Chemical Kinetics, Surface Chemistry, General Principles and Processes of Isolation of Elements, *p*-Block Elements (Group 15 to 18), *d*- & *f*-Block Elements, Coordination Compounds, Haloalkanes and Haloarenes, Alcohols, Phenols and Ethers, Aldehydes, Ketones and Carboxylic Acids, Amines, Biomolecules, Polymers, Chemistry in Everyday Life.

Section – 2 : Higher Order Thinking Questions - Syllabus as per Section – 1.

Section – 3 : Relations and Functions, Inverse Trigonometric Functions, Matrices and Determinants, Continuity and Differentiability, Application of Derivatives, Integrals, Application of Integrals, Differential Equations, Vector Algebra, Three Dimensional Geometry, Probability, Linear Programming.

OR

Section – 3 : Reproduction, Genetics and Evolution, Biology in Human Welfare, Biotechnology, Ecology.

Total Questions : 50 Time : 1 hr.

PATTERN & MARKING SCHEME

Section	(1) Physics & Chemistry	(2) Achievers Section	(3) Mathematics or Biology
No. of Questions	25	5	20
Marks per Ques.	1	3	1

Practice Questions

1. Which is the correct order of geological time scale for vertebrate evolution?

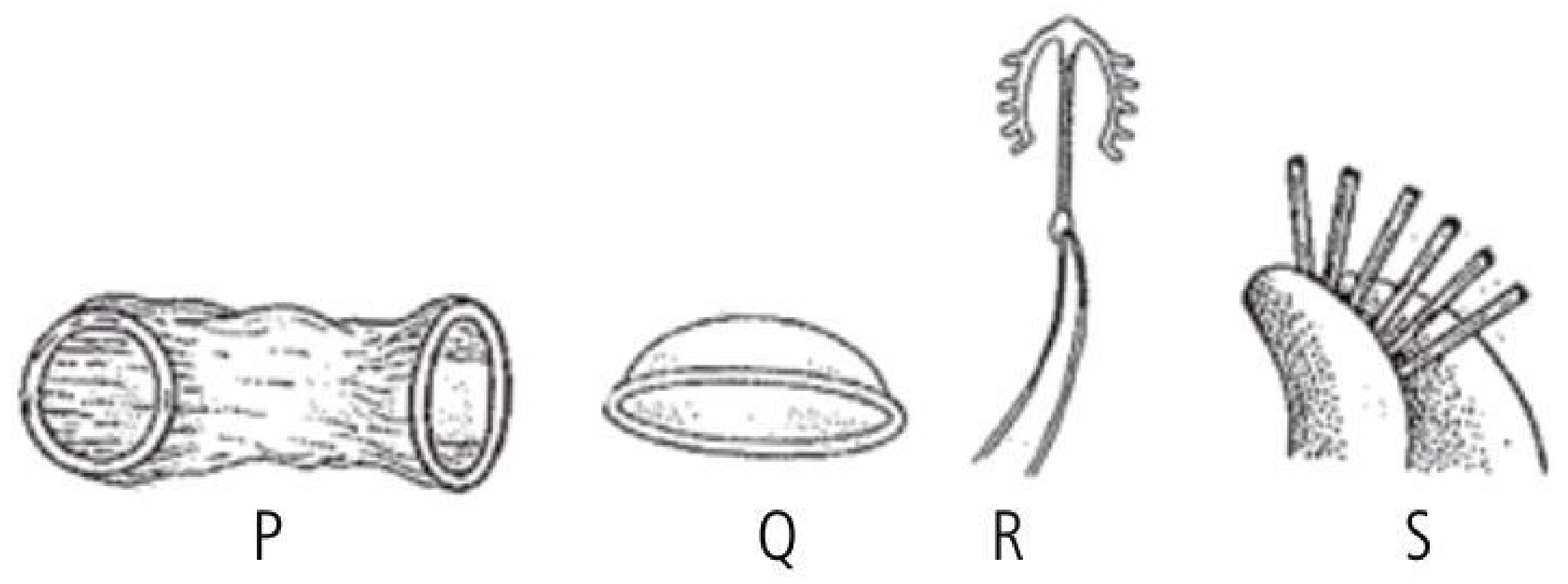
A. Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic

B. Ordovician, Devonian, Carboniferous, Silurian, Permian, Triassic

C. Ordovician, Devonian, Silurian, Carboniferous, Triassic, Permian,

D. Ordovician, Silurian, Devonian, Permian, Carboniferous, Triassic

2. Select the correct statements for the given figures.



(i) P-is male condom made of thin rubber latex used to cover the testis and penis during coitus.

(ii) Q-is diaphragm that covers entrance of the uterus and prevents a sperm from reaching an egg.

(iii) R-is Multiload, an intrauterine device which suppresses motility and fertilising capacity of sperms.

(iv) S-is Depo-Provera, a progesterone derivative IUD which releases hormone slowly and prevents ovulation.

A. (ii) and (iii) B. (i), (ii) and (iii)
C. (ii), (iii) and (iv) D. (i) and (iii)

3. During the stages of succession in a given ecosystem, the following changes in characteristics may be observed.

	Characteristic	Stages in ecosystem development	
		Early	Late
P.	Total organic matter	Low	High
Q.	Species diversity	Low	High
R.	Size of organism	Small	Large
S.	Food chains	Short	Long

Which one of the characteristics P, Q, R or S is responsible for the apparent high degree of stability associated with a climax ecosystem?

A. Q B. S C. P D. R

4. Consider the following microbes.

> *Bacillus anthracis*, *Vibrio cholerae*
> Small pox virus, *Yersinia pestis*
> *Clostridium botulinum*, *E.coli*,
> *Rhizobium*, *Pseudomonas denitrificans*

How many of these can be potential pathogens for use as bioweapons?

A. 5 B. 3 C. 4 D. 8

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5. Which of the following statements are incorrect?

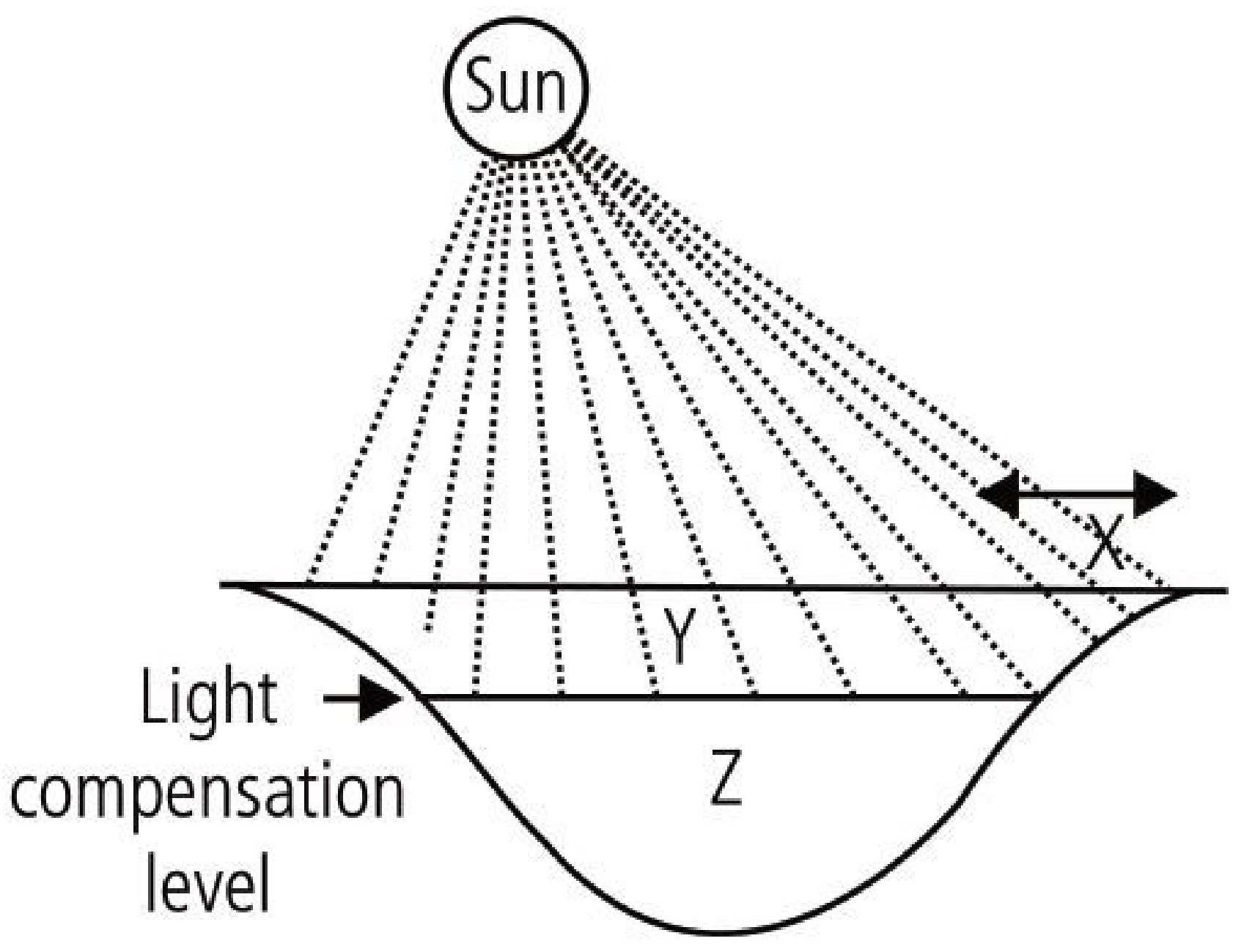
(i) Type II restriction enzymes require ATP, Mg^{2+} and S-Adenyl methionine for restriction.
(ii) *Hind* II always cuts DNA molecules at a particular point by recognising a specific sequence of six base pairs.
(iii) Separated DNA fragments cannot be visualised without staining on an agarose gel electrophoresis.
(iv) '*Ori*' is the sequence responsible for controlling the copy number.
(v) Reverse transcriptase is a DNA ligase.

A. (i) and (iii) B. (i) and (v)
C. (i) and (ii) D. (ii) and (iv)

6. The distances between genes W, X, Y and Z on a chromosome are as follows : W-Y is 18 units, W-X is 26 units, W-Z is 40 units, X-Y is 8 units and X-Z is 14 units. The sequence of these genes would be

A. W, X, Y, Z B. W, Y, X, Z
C. X, Y, W, Z D. Y, W, X, Z.

7. Given figure represents the different zones of a lake or a pond.



Identify the labelled parts X, Y and Z and select the correct statement(s).

A. X constitutes the shallow water banks and is called as littoral zone.
B. Y constitutes the open water zone upto which light can penetrate and is called as profundal zone.
C. Z constitutes the deep water zone where light cannot penetrate and is called as limnetic zone.
D. All of these

8. How many of the given seeds are albuminous?

Castor, maize, groundnut, pea, wheat, barley, gram, rubber, coconut, bean

A. 5 B. 4 C. 6 D. 7

9. Which of the following groups does not include the countries which contribute to megadiversity centres of the world?

(i) Mexico, Colombia, Brazil
(ii) Peru, Ecuador, Venezuela
(iii) Madagascar, Indonesia, Malaysia
(iv) China, Germany, Japan

A. (ii) B. (i) C. (iii) D. (iv)

10. A retrovirus with a reverse transcriptase enzyme infects a eukaryotic cell and forms a protein whose RNA reads as 5′AUCGACGAUACGAAAGCCGUACGCUAU3′
What will be the corresponding sequence in its original genome?

A. 5′TAGCTGCTATGCTTTCGGCATGCGATA3′
B. 5′AUCGACGAUACGAAAGCCGUACGCUAU3′
C. 5′UAGCUGCUAUGCUUUGCCGAUGCGAUA3′
D. 5′ATCGACGATACGAAAGCCGTACGCTAT3′

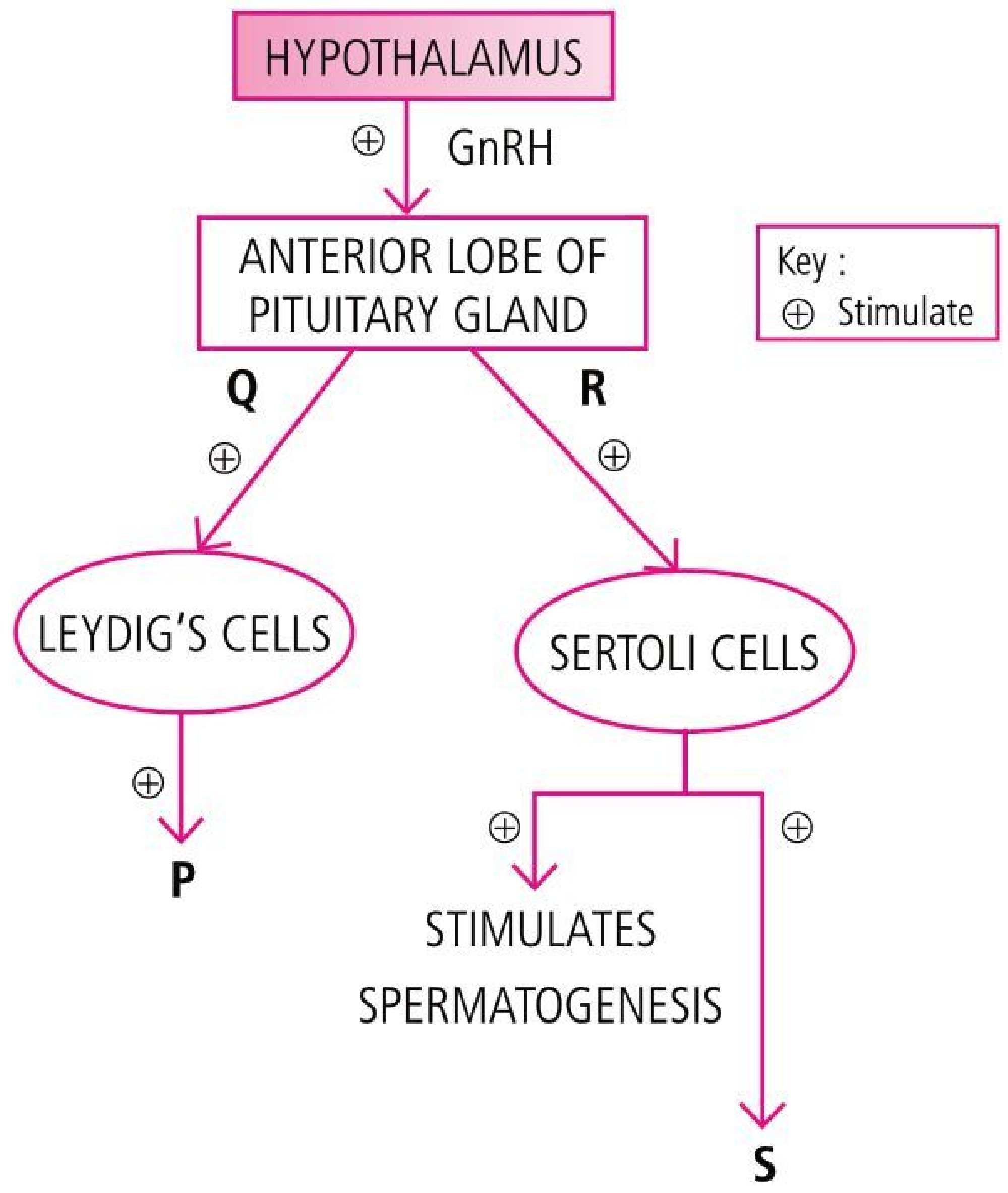
11. A male papaya plant with 26 chromosomes in its pollen mother cells is crossed with female papaya plant bearing 26 chromosomes in its root cells. What would be the ploidy of zygote and endosperm respectively formed after this cross?

A. 26 and 52 B. 26 and 26
C. 52 and 78 D. 26 and 39

12. A person is diagnosed with the symptoms of a sexually transmitted disease, where warts develop over the skin and mucosal surface of external genitalia and perianal area. Identify the causative organism of the disease.

A. *Haemophilus ducreyi*
B. *Treponema pallidum*
C. Human papilloma virus
D. *Neisseria gonorrhoeae*

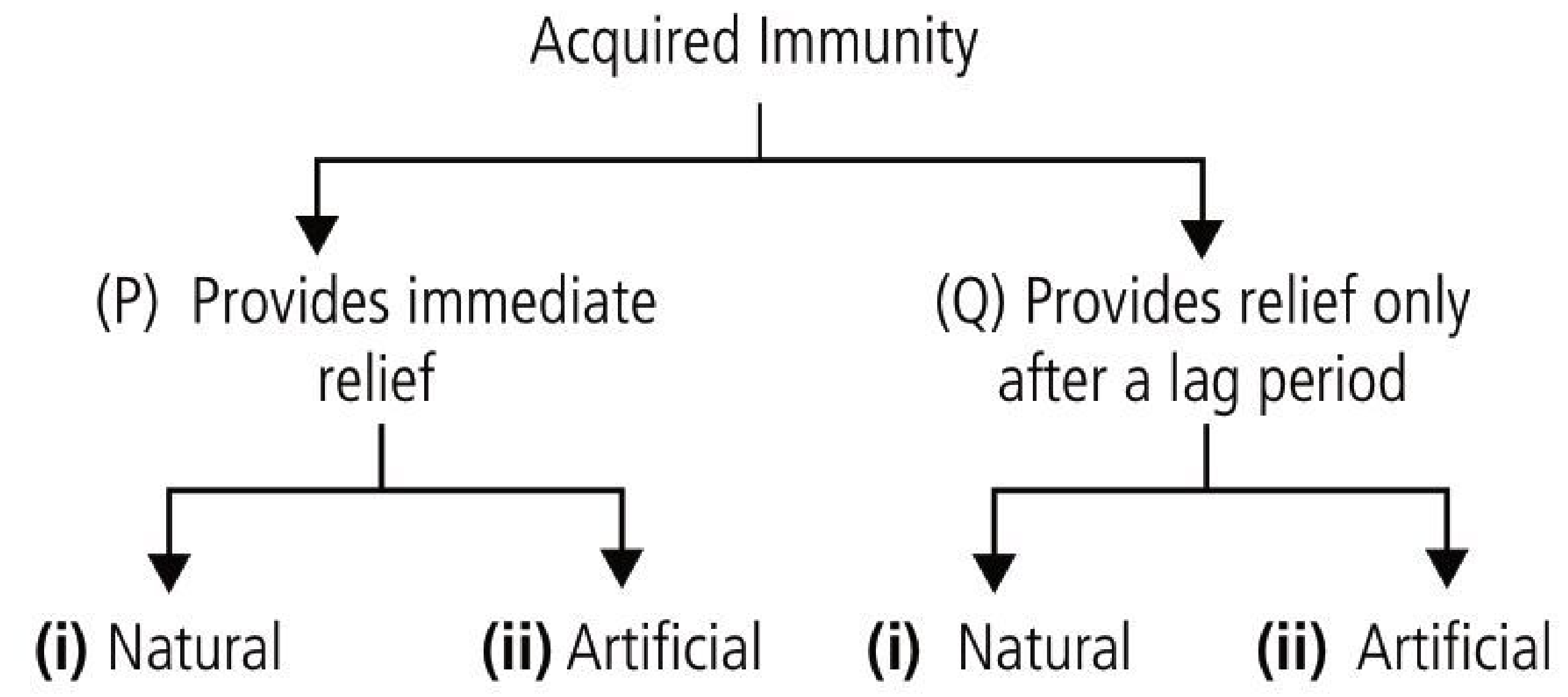
13. Identify P, Q, R and S in the given flow chart representing the hormonal control of male reproductive system and select the incorrect option regarding them.



A. Hormone P brings about the growth of secondary sex organs in males during puberty.
B. Hormone Q is also present in females and stimulates the corpus luteum to secrete progesterone in them.
C. Hormone R is also present in females and stimulates the growth of follicles and secretion of estrogen in them.
D. Hormone S inhibits the secretion of androgen by Leydig's cells of the testis in males.

14. A man with blood group 'AB' is married to a woman with blood group 'O'. They have two biological children and one adopted child. The blood groups of three children are A, B and O. Which of the three children is adopted one?
A. Child with 'A' blood group
B. Child with 'B' blood group
C. Child with 'O' blood group
D. Cannot be predicted.

15. The given flow chart shows classification of acquired immunity. What types of immunity will be developed by the persons X and Y?


Acquired Immunity
(P) Provides immediate relief
(Q) Provides relief only after a lag period
(i) Natural
(ii) Artificial
(i) Natural
(ii) Artificial

X : A person who has recovered from an attack of measles.
Y : A person who is given anti-tetanus serum.

	X	Y		X	Y
A.	(P) (i)	(Q) (i)	B.	(Q) (i)	(P) (ii)
C.	(Q) (ii)	(P) (ii)	D.	(P) (i)	(Q) (ii)

16. Refer to the following table showing differences between J-shaped and sigmoid growth.

	J-shaped growth	Sigmoid growth
(P)	It occurs when the resources are limited.	It occurs when the resources are abundant.
(Q)	It has two phases.	It has four phases.
(R)	Population seldom grows beyond the carrying capacity of ecosystem.	Population passes well beyond the carrying capacity of ecosystem.
(S)	It occurs in fewer organisms, *e.g.*, Lemmings, algal bloom.	It is more common, *e.g.*, members of wildlife.

The incorrect pair of differences are
A. (P) and (Q)　B. (Q) and (R)
C. (R) and (S)　D. (P) and (R).

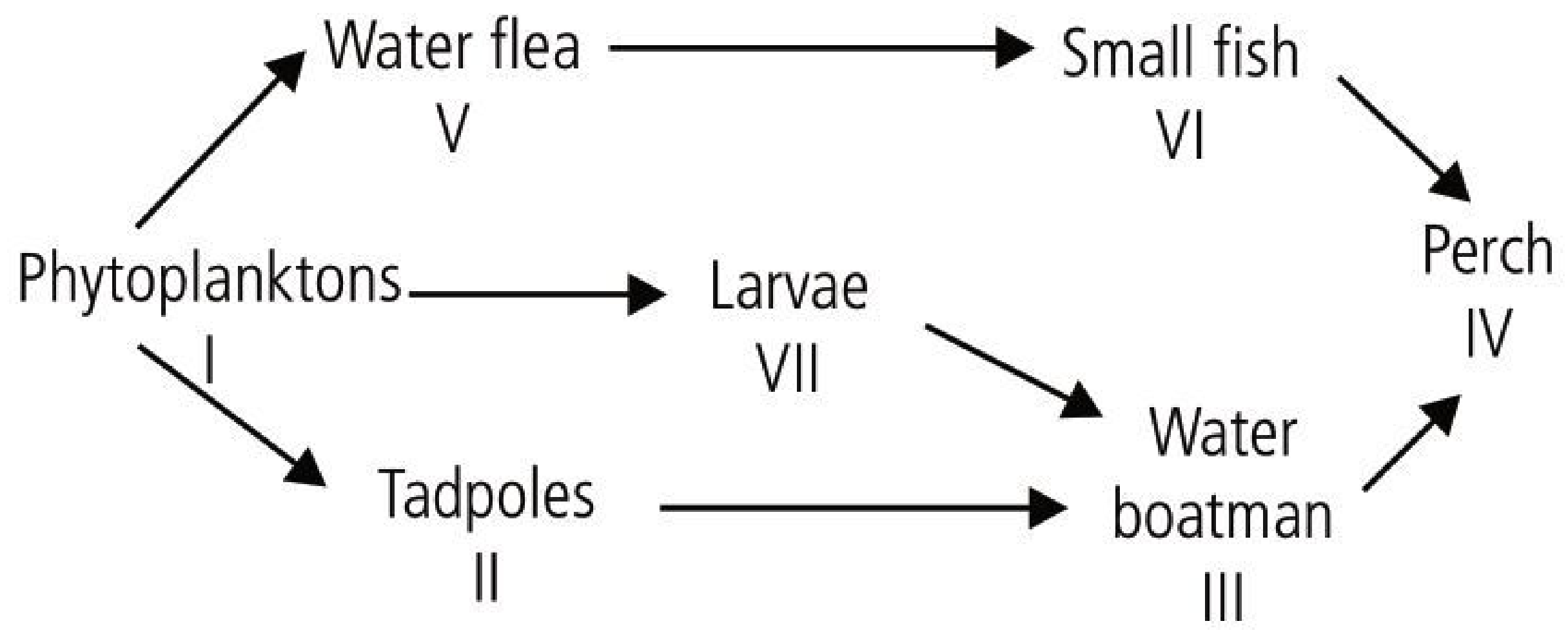
17. The diagram shows a section of a DNA molecule.
ATCGTAGAATTCGGCAGCTGGCATTAGAATTCCTAGGAAGCTATTGG
TAGCATCTTAAGCCGTCGACCGTAATCTTAAGGATCCTTCGATAACC
This molecule was cut under ideal conditions, using two different endonucleases, *EcoR* I and *Alu* I, which recognise different restriction sites.

*Eco*R I	GAATTC CTTAAG	*Alu* I	AGCT TCGA

What is the number of DNA fragments that can be produced?
A. 4　B. 6　C. 5　D. 8

18. Given below are four statements (P-S) each with one or two blanks. Select the option which correctly fills up the blanks in the two statements.
(P) Plague is caused by _(i)_, a deadly bacterium. _(ii)_, the most common form of plague which is characterised by high fever, weakness and acute painful swellings of the lymph nodes.
(Q) Filariasis is characterised by swelling of the _(i)_ and of other parts of the body. The disease, therefore, is commonly known as _(ii)_ due to its resemblance to leg of an elephant.
(R) _(i)_ is the resistance to infection which an individual possesses by virtue of his/her genetic and constitutional make up.
(S) _(i)_ literally means "protection against self". _(ii)_ is an example of it.
A. (Q)-(i) Neck, (ii) Ascariasis, (S)-(i) Autoimmunity, (ii) Diabetes mellitus
B. (P)-(i) *Bordetella pertussis*, (ii) Pulmonary plague (R)-(i) Passive immunity
C. (P)-(i) *Yersinia pestis*, (ii) Bubonic plague (S)-(i) Autoimmunity, (ii) Rheumatoid arthritis
D. (Q)-(i) Leg, (ii) Elephantiasis, (R)-(i) Acquired immunity

19. Which of the following organisms in the given food web act both as a predator and a prey?



A. I, II and IV　B. II, III and V
C. II, III, V, VI and VII　D. II, III and VI

20. Read the following statements and choose the correct option.
P. Nitrogenous base is linked to the pentose sugar through a N-glycosidic linkage.
Q. Phosphate group is linked to 5′-OH of a nucleoside through phosphoester linkage.

UNSCRAMBLED WORDS

DECEMBER 2022

1-g-ARTHRITIS	2-d-MONOECIOUS
3-j- BIOMASS	4-c-ANAPHASE
5-b- PATHOGEN	6-e-HISTONE
7-f-POLLINATION	8-i-ETHYLENE
9-a-ZYGOTE	10-h-INBREEDING

Winner : *Sagnik Ganguly (Noida, Uttar Pradesh)*

R. Two nucleosides are linked through 3′ – 5′ N-glycosidic linkage.
S. Negatively charged DNA is wrapped around positively charged histone octamer to form nucleosome.
T. The chromatin that is more densely packed and stains dark is called euchromatin.

A. P, Q and R alone are wrong
B. S alone is wrong
C. R and T alone are wrong
D. P alone is wrong

Darken your choice with HB Pencil

1.	Ⓐ Ⓑ Ⓒ Ⓓ	**5.**	Ⓐ Ⓑ Ⓒ Ⓓ	**9.**	Ⓐ Ⓑ Ⓒ Ⓓ	**13.**	Ⓐ Ⓑ Ⓒ Ⓓ	**17.**	Ⓐ Ⓑ Ⓒ Ⓓ
2.	Ⓐ Ⓑ Ⓒ Ⓓ	**6.**	Ⓐ Ⓑ Ⓒ Ⓓ	**10.**	Ⓐ Ⓑ Ⓒ Ⓓ	**14.**	Ⓐ Ⓑ Ⓒ Ⓓ	**18.**	Ⓐ Ⓑ Ⓒ Ⓓ
3.	Ⓐ Ⓑ Ⓒ Ⓓ	**7.**	Ⓐ Ⓑ Ⓒ Ⓓ	**11.**	Ⓐ Ⓑ Ⓒ Ⓓ	**15.**	Ⓐ Ⓑ Ⓒ Ⓓ	**19.**	Ⓐ Ⓑ Ⓒ Ⓓ
4.	Ⓐ Ⓑ Ⓒ Ⓓ	**8.**	Ⓐ Ⓑ Ⓒ Ⓓ	**12.**	Ⓐ Ⓑ Ⓒ Ⓓ	**16.**	Ⓐ Ⓑ Ⓒ Ⓓ	**20.**	Ⓐ Ⓑ Ⓒ Ⓓ

SOLUTIONS

1. (A) : The correct order of geological time scale for vertebrate evolution is
Ordovician (500 mya) ⟶ Silurian (440 mya) ⟶ Devonian (400 mya) ⟶ Carboniferous (350 mya) ⟶ Permian (280 mya) ⟶ Triassic (225 mya)

2. (A) : P is female condom made of thin rubber/latex sheath used to cover the vagina and cervix in the female just before coitus. S is implant which consists of progestogens alone or in combination with estrogen.

3. (A) **4. (A)**

5. (B) : Type I restriction endonuclease require ATP, Mg^{2+} and S-adenosyl methionine for restriction while Type II restriction enzymes require Mg^{2+} ions for restriction. The enzyme reverse transcriptase catalyses formation of DNA from *m*RNA. DNA ligase catalyses joining of two fragments.

6. (B)

7. (A) : Y – Photic zone of limnetic zone. Limnetic zone is open water zone upto the depth to which light can penetrate.
Z – Profundal zone. It is deep water zone where the light does not penetrate.

8. (C)

9. (D) : There are 17 megadiversity countries of the world. These are Australia, Brazil, China, Colombia, Democratic Republic of the Congo, Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, Phillippines, South Africa, United States and Venezuela.

10. (B) **11. (D)**

12. (C) : Genital warts that is caused by Human papilloma virus warts develop over the skin and mucosal surface of external genitalia and perianal area.

13. (D)

14. (C)

15. (B)

16. (D) : J shaped growth occurs when the resources are abundant whereas sigmoid growth occurs when the resources are limited. In J shaped growth, population passes well beyond the carrying capacity of the ecosystem whereas in logistic growth, population seldom grows beyond the carrying capacity of ecosystem.

17. (C)

18. (C)

19. (C)

20. (C) : Two nucleosides are linked through 1 – 4 glycosidic linkage where the bond is normally formed between the carbon 1 of one sugar and carbon 4 of other sugar. The chromatin that is more densely packed and stains dark is called as heterochromatin.

For other sections/subjects please refer to Physics For You and Chemistry Today

☺☺

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ELIGIBILITY

The basic eligibility criteria for pursuing Bachelor of Fisheries Science (B.F.Sc.) course is minimum 50% in 10+2 with subjects Physics, Chemistry and Biology/Mathematics from a recognised college or university.

SELECTION CRITERIA

Admission to B.Sc Fisheries is done through state-level or university-level entrance examinations *via* all India level Indian Council of Agricultural Research (ICAR) examination. Other entrance admission exams for B.F.Sc are:

(i) Graduate Pharmacy Aptitude Test (GPAT)
(ii) Andhra University Common Entrance Test (AUCET,)
(iii) LPU NEST
(iv) JNU Engineering, Agricultural and Medical Common Entrance Test (JNU EAMCET),
(v) Junagarh Agricultural University Entrance Test,
(vi) Karnataka Common Entrance Test
(vii) Maharana Pratap University Pre Post Graduate Test,
(viii) The Central Institute of Fisheries, Nautical & Engineering Training (CIFNET)

TOP COLLEGES OFFERING B.Sc. IN FISHERY SCIENCE

(i) **Kerala university of Fisheries and Ocean Studies**
(ii) Cochin university of Science and Technology
(iii) Patna University
(iv) Govind Ballabh Pant University of Agriculture and Technology
(v) University of Calcutta
(vi) Aligarh Muslim University
(vii) Junagarh Agriculture University.

All information related to admission and entrance examination can be checked on the college's official websites. Most of the entrance examinations are generally conducted between January and February. The entrance exams are generally conducted in online mode. ☺☺

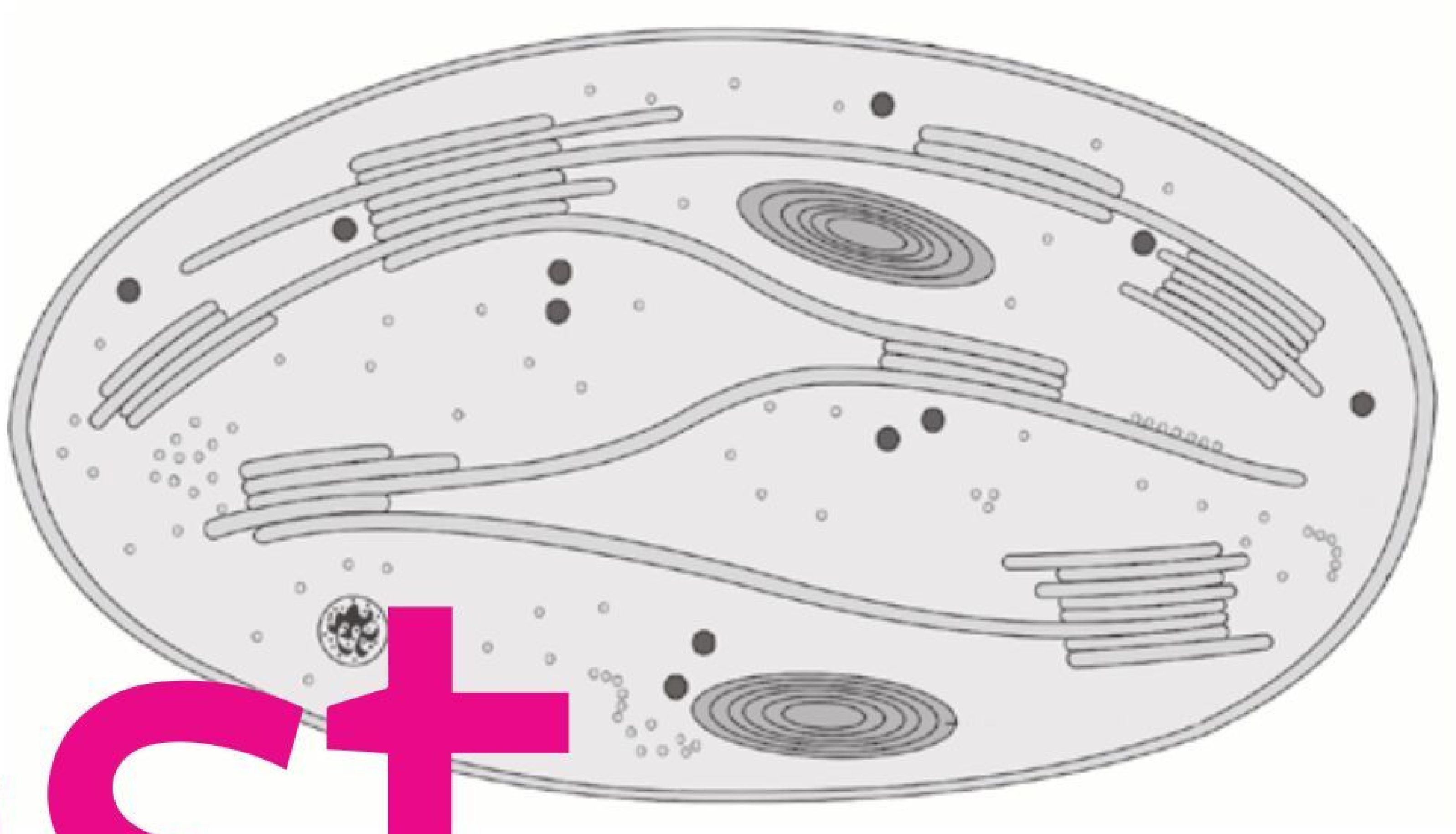
KERALA UNIVERSITY OF FISHERIES AND OCEAN STUDIES (KUFOS)

The Kerala University of Fisheries and Ocean Studies is a university established by the Government of Kerala devoted to studies in fisheries and ocean sciences. It is an autonomous publicly funded institution established on 20 November 2010. It is a hub for studies conducted in the field of fisheries and ocean sciences and offers UG, PG, PhD, PDF, diploma and certification courses in Engineering, Management, Fisheries Science etc., disciplines.

(i) Selection to the B.F.Sc course is based on the candidate's merit in **Kerala Engineering Agricultural Medical Entrance Exam (KEAM)** or **NEET-UG**.
(ii) Candidates' merit in the All India Entrance Examination conducted by ICAR is also considered.

Class XI

BIO Digest



This article covers high yield facts of the given topic.

Photosynthesis in Higher Plants

- Photosynthesis is the physico-chemical process by which plants, algae and few bacteria transduce light energy into chemical energy. The photosynthetic process results in the release of molecular oxygen and the absorption of carbon dioxide from the atmosphere which is used to synthesise carbohydrates.
- Photosynthesis is an **oxidation-reduction process** in which water is oxidised to release O_2 and CO_2 is reduced to form sugars.
- The overall general equation of photosynthesis is as follows:

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2\uparrow + 6H_2O$$

- **In 1941, Ruben** and **Kamen** experimentally proved that the source of liberated oxygen in photosynthesis is water, and not carbon dioxide.
- Photosynthesis occurs in plants, algae, and many species of bacteria, but not in archaea.
- About **90%** of total photosynthesis in the world is performed by algae in oceans, and in freshwater.
- Carbon dioxide fixed annually through photosynthesis taking place on both terrestrial and aquatic levels is about **258 gigatonnes.**
- Photosynthetic organisms are called **photoautotrophs,** since they can produce their own food.
- Purple bacteria (*e.g.*, Thiorhodaceae), green sulfur bacteria (*e.g.*, Chlorobiaceae), green gliding bacteria (*e.g.*, Chloroflexaceae) and helio bacteria (*e.g.*, Firmicutes species) use light energy to create organic compounds, but do not produce oxygen. It is called **anoxygenic photosynthesis**.

RAW MATERIALS OF PHOTOSYNTHESIS

Carbon Dioxide

- Land plants get carbon dioxide from the atmosphere through the **stomata.**
- Hydrophytes get their carbon dioxide supply in the form of bicarbonates from the aquatic environment, through their general surface.

Water

- In the process of photosynthesis, water is the source of liberated oxygen. Photosynthetic land plants absorb a large amount of water from the soil through the root hair.
- But, relatively very small amount of this absorbed water (about 1%) is used in the process of photosynthesis.
- Aquatic photosynthetic plants absorb water through their body surface.

Light

- The visible part of electromagnetic radiations is light. Electromagnetic radiations are a form of energy that consist of a stream of tiny particles called **photons**, which travel in waves.
- Solar radiations reaching the earth have wavelength between 300 nm (in the ultraviolet range) to 2600 nm (in the infrared range).
- Part of the spectrum used in photosynthesis has a wavelength between 400-700 nm. It is called **photosynthetically active radiation (PAR)**.
- The energy contained in a photon is termed as **quantum**. The energy content of a quantum is related to its wavelength. The shorter the wavelength, the greater is the energy present in its quantum.
- Blue and red regions of the light spectrum are the most effective in photosynthesis. Blue wavelengths of light carry more energy while red wavelengths have lesser energy.
- The most efficient wavelength of light effective in photosynthesis is that of red light. Green light is the least effective in photosynthesis.

Chloroplasts

- Chloroplasts are the actual site of photosynthesis. These are **green plastids** which occur in all the green parts of the plants. These are round, oval or disc-shaped bodies.
- They occur mostly in the chlorenchymatous cells (particularly in **mesophyll**) of leaves and young stems. Each mesophyll cell may contain as many as **300 chloroplasts** in its peripheral cytoplasm.
- The chloroplast of higher plant is an organelle with an outer envelope consisting of a **double membrane,** which acts as a **selective barrier** to the movement of cellular metabolites into or out of the chloroplasts.
- The chloroplast envelope encloses a liquid proteinaceous matrix called **stroma.** The liquid medium of stroma is hyaline, slightly dense, granular matrix and contains all the necessary **enzymes of photosynthesis.**
- The **lamellar system** within the stroma forms flattened sac like lamellae called **thylakoids** (Gk. *thylakos* = sac, *oid* = like). These thylakoids are stacked to form **grana.**

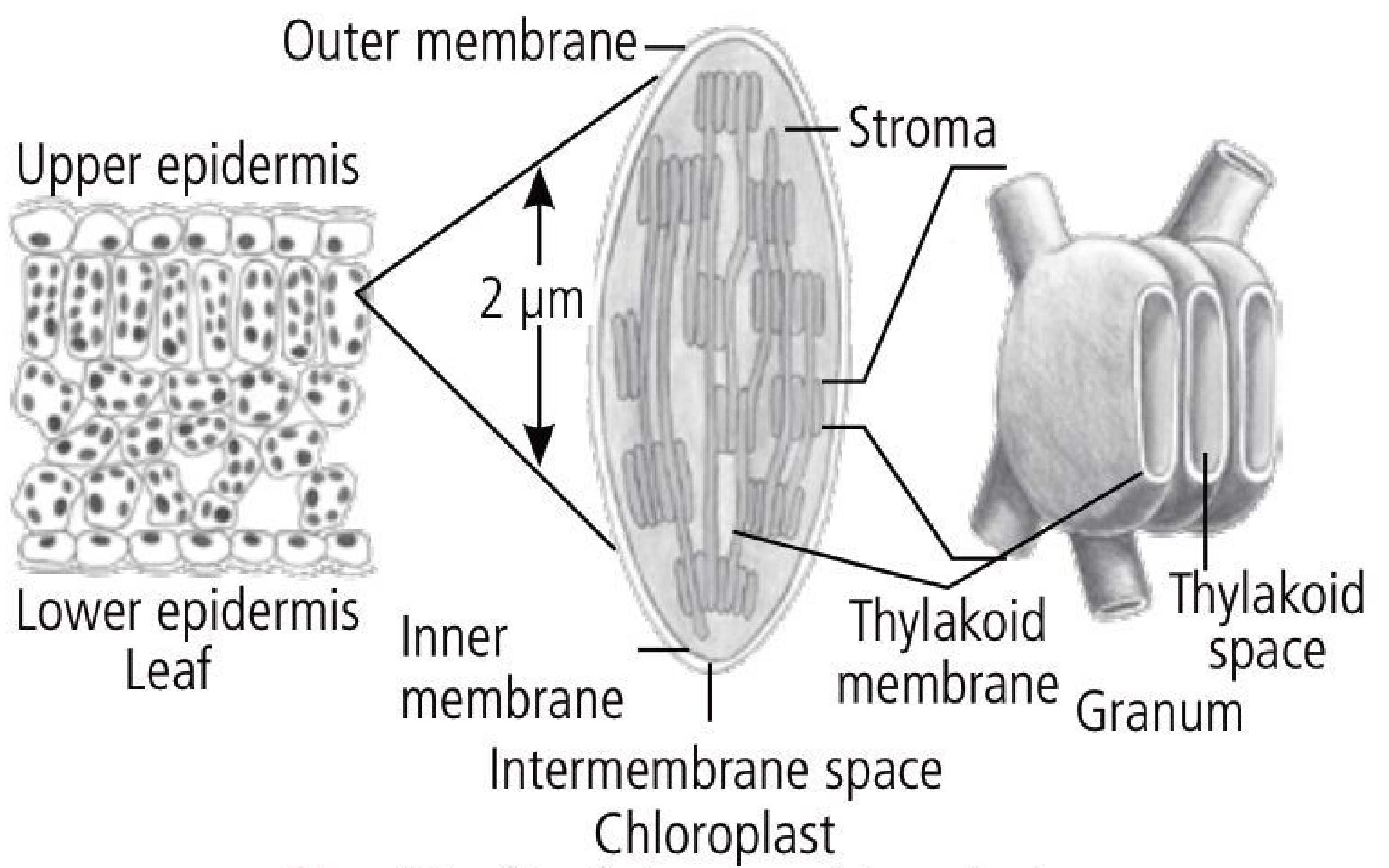


Fig.: T.S of leaf showing chloroplast

Photosynthetic Pigments

- Those pigments which occur on photosynthetic thylakoids of chloroplasts and take part in absorption of light energy for the purpose of photosynthesis are known as **photosynthetic pigments.**
- Photosynthetic pigments are of two types – **chlorophylls** and **carotenoids.**
- All chlorophylls and most carotenoids are embedded within thylakoids and are attached by non-covalent bonds to protein molecules.

Chlorophylls

- Chlorophylls are the green photosynthetic pigments.
- Five types of chlorophylls occur in plants other than bacteria – *a*, *b*, *c*, *d* and *e*. Out of these, only two chlorophylls occur in the chloroplasts of higher plants, *a* and *b*.
- The amount of chlorophyll *b* is roughly one fourth of total chlorophyll content.
- Chlorophyll *a* is found in all photosynthetic plants, hence, it is termed as universal photosynthetic pigment or **primary photosynthetic pigment** because it performs primary reaction of photosynthesis which involves conversion of light into chemical or electrical energy.
- Other photosynthetic pigments are hence called **accessory pigments**.
- Chlorophyll structure was first studied by Willstatter, **Stoll** and **Fischer in 1912**.
- It has a tadpole like configuration with a head called **porphyrin** and a long **phytol** tail**.** Porphyrin head is made up of **four pyrrole rings** which are linked by **methine** bridges (=CH–).
- The skeleton of each pyrrole ring is made up of five atoms– four carbon and one nitrogen. The latter lies towards the centre.
- A non-ionic **magnesium atom** is held in the centre of porphyrin head by nitrogen atoms of pyrrole rings (through two covalent and two coordinate bonds).
- Chlorophyll *a* is bluish-green in pure state. It has an empirical formula of **$C_{55}H_{72}O_5N_4Mg$**.
- Chlorophyll *b* is olive green in pure state with an empirical formula of $C_{55}H_{70}O_6N_4Mg$.
- Both the chlorophylls are soluble in a number of organic solvents, but chlorophyll *a* is more soluble in non polar solvent like petroleum ether, while chlorophyll *b* is more soluble in polar solvent like methyl alcohol.
- Chlorophyll *a* has methyl ($-CH_3$) group at carbon-3 while chlorophyll *b* has formyl or aldehyde (–CHO) group.
- Chlorophyll *a* absorbs more red wavelength while chlorophyll *b* absorbs more violet blue wavelength.
- Bacteria possess two types of photosynthetic pigments-bacteriochlorophyll and bacterioviridin. Bacteriocholorphyll *a* has an empirical formula of $C_{55}H_{74}O_6N_4Mg$.

Carotenoids

- Carotenoids are a group of **yellow, orange** to **reddish pigments** which are associated with the chlorophylls inside the chloroplasts, but occur alone inside the chromoplasts.
- The carotenoids are also called **accessory pigments**.
- Carotenoids have **conjugate double bonds** (—C=C—C=C—).
- They are of two types, **carotenes** and **xanthophylls.**
- Carotenes are hydrocarbons with a general formula of $C_{40}H_{56}$. Red colour of tomatoes is due to carotene called **lycopene.** The most common carotene is **β-carotene.** It is converted to **vitamin A** by animals and human beings.
- Xanthophylls are oxygen containing derivatives of carotenes *e.g.*, $C_{40}H_{56}O$ (cryptoxanthin), $C_{40}H_{56}O_2$ (lutein, zeaxanthin).

Phycobilins

- The **phycobilins** constitute a major group of photosynthetic pigments occurring in blue-green algae (cyanobacteria), cryptomonads and red algae.
- They are protein linked pigments (*i.e.*, biliproteins), which get destroyed by heat.
- These water soluble pigments are localised in small granules, called **phycobilisomes**, attached to thylakoids.
- These pigments are open tetrapyrrole like chlorophylls, but do not contain magnesium and phytol chain.
- They absorb light and help in photosynthesis.
- There are two types of phycobilins: **phycocyanin** and **phycoerythrin.**
- Blue green algae have more quantity of phycocyanin whereas red algae have more phycoerythrin.

INTEXT PRACTICE QUESTIONS

1. **Why photosynthesis is an oxidation-reduction process?**
2. **How many pyrrole rings made porphyrin head of chlorophyll? What are the different types of chlorophylls in plants?**

Red Drop and Emerson Effect

- **Quantum yield** is the molecule of CO_2 fixed per mole of quanta absorbed or else the efficiency with which light is converted into fixed carbon.
- Emerson (1957) found a sharp reduction in the rate of photosynthesis when monochromatic light of more than 680 nm wavelength (red region of the spectrum) was used alone. It is called **red drop effect**.
- He observed that rate of photosynthesis increases when the longer and the shorter wavelengths were supplied simultaneously.
- He concluded that simultaneous application of light of shorter and longer wavelengths, increases the rate of photosynthesis. This is called **Emerson's enhancement effect.**
- It is due to :
  - Presence of different types of harvesting molecules around a trap centre in a photosynthetic unit and
  - Presence of two interconnected pigment systems with some common pigments.

Absorption Spectrum

- A graph showing amount of energy of different wavelengths of light absorbed by a substance is called **absorption spectrum.**
- It is measured with the help of **spectrophotometer.**
- The absorption spectra of chlorophylls *a* and *b* show that they absorb maximum light in the blue-violet and red wavelengths range.
- The pigments are often known after the wavelength which is absorbed to the maximum, *e.g.*, Chl a_{673}, Chl a_{683} (P_{680}), Chl a_{703} (P_{700}).

Action Spectrum

- The graphic curve depicting the relative rates of photosynthesis at different wavelengths of light is called action spectrum.
- It shows that maximum photosynthesis occurs in **blue-violet** and **red** parts of the spectrum.
- Action spectrum of photosynthesis corresponds closely to absorption spectra of chlorophyll *a* and *b* showing that these are the main photosynthetic pigments.

Photosynthetic Unit

- A photosynthetic unit is the smallest group of pigment molecules which takes part in a photochemical act or conversion of light energy into chemical energy. It has a **photocentre** or **reaction centre** which is fed by about 200 light harvesting pigment molecules.
- The photocentre consists of a dimer of special chlorophyll *a* molecules, P_{700} or P_{680} (named after maximum absorption of pigment or protocentre). Reaction centre absorbs light energy at longer wavelengths.
- The harvesting molecules form a protein based complex called **light harvesting complex (LHC).** LHC consists of two parts, **antenna** and **core molecules**.

- In green plants, photosynthetic units occur in the form of two distinct groups called **photosystems** or **pigment systems I** and **II.** The two pigment systems are named in order of their discovery.

Photosystem I (PS I)

- It is a photosynthetic pigment system alongwith some electron carriers that is located in stroma thylakoids and non-appressed regions of granal thylakoids.
- PS I has more of chlorophyll *a* as compared to chlorophyll *b* and carotenoids.
- Photosystem I consists of a photocentre, light harvesting complex (LHC I) and some electron carriers. The reaction centre of photosystem I has a dimer of special chlorophyll *a* molecules called P_{700}. Photosystem I has a reducing agent A_0 (chlorophyll P_{700} molecule), A_1 (a quinone), Fe S_x, Fe S_A and Fe S_B (iron-sulphur proteins), Fd (ferredoxin), cytochrome b_6–f complex and plastocyanin.

Photosystem II (PS II)

- It is a photosynthetic pigment system alongwith some electron carriers that is located in the appressed part of the grana thylakoids. PS II has chlorophyll *a*, *b* and carotenoids. Chl *a* and chl *b* contents are equal. Carotenoid content is higher as compared to that of PS I.
- Photosystem II consists of a photocentre, oxygen evolving complex, light harvesting complex (LHC II) and some electron carriers. All are connected to membrane proteins. Photocentre has a dimer of special chlorophyll *a* molecules called P_{680}.
- Other components of PS II are phaeophytin, plastoquinone (PQ), cytochrome b_6–f complex and blue coloured copper containing plastocyanin.

MECHANISM OF PHOTOSYNTHESIS

- Photosynthesis occurs in two phases - **photochemical** and **biosynthetic**.
- Photochemical phase is also called **light** or **Hill reaction** (after the name of the scientist, Robert Hill who discovered its details).
- Biosynthetic phase is also termed as **dark** or **Blackman's reaction** (after the name of scientist, F.F. Blackman who first postulated it).

LIGHT REACTION (PHOTOCHEMICAL PHASE)

- It occurs **inside the thylakoids,** especially those of **grana region.** It is light **dependent** step**.**
- Photochemical phase involves **photolysis of water** and **production of assimilatory power** (NADPH and ATP).
- The phenomenon of breaking up of water into hydrogen and oxygen in the illuminated chloroplast is called **photolysis** or **photocatalytic splitting of water.**
- Light energy and an oxygen evolving complex (OEC) are essential requirements for light reactions.

Photophosphorylation

- The term photophosphorylation was coined by **Arnon** *et al* in 1954. The light driven synthesis of ATP in the chloroplast by photosynthesis is called photophosphorylation.
- Photophosphorylation is also called photosynthetic phosphorylation. It differs from **oxidative phosphorylation**. Photophosphorylation is of two main types : **cyclic** and **non-cyclic.**

Cyclic photophosphorylation

- It is a process of photophosphorylation in which an electron expelled by the excited photocentre is returned to it after passing through a series of electron carriers.
- It occurs under conditions of low light intensity, wavelength longer than 680 nm and when carbon dioxide fixation is inhibited.
- Cyclic photophosphorylation is performed by **photosystem I only**.
- Photocentre P_{700} extrudes an electron with a gain of 23 kcal/mole of energy after absorbing a photon of light. After losing the electron, the photocentre becomes oxidised.
- The expelled electron passes through a series of carriers including P_{700} chlorophyll molecule, plastoquinone (PQ), FeS complex, ferredoxin (Fd), cyt b_6–f and plastocyanin before returning to photocentre.
- Over the cytochrome complex (cyt b_6–f), the electron creates a proton gradient for the synthesis of ATP from ADP and inorganic phosphate.

Non-cyclic photophosphorylation

- It is the normal process of photophosphorylation in which the electron expelled by the excited photocentre does not return to it.
- Non-cyclic photophosphorylation is carried out in collaboration of both **photosystem I and photosystem II**.
- Electron released during photolysis of water is picked up by photocentre of PS II called P_{680}.
- The same is extruded out when the photocentre absorbs light energy.
- It passes through a series of electron carriers – phaeophytin, PQ, cytochrome b_6–f complex and plastocyanin.
- While passing over cytochrome complex (cyt b_6–f), the electron loses sufficient energy for the synthesis of ATP.
- The electron is handed over to photocentre P_{700} of PS I by plastocyanin. P_{700} extrudes the electron after absorbing light energy. The extruded electron passes through a chain of electron acceptors through Fe-S, ferredoxin and finally reach $NADP^+$.
- The latter then combines with H^+ (released during photolysis) with the help of NADP-reductase to form NADPH.
- This is called Z scheme due to its characteristic zig-zag shape based on redox potential of different electron carriers.

Chemiosmotic Hypothesis of ATP Formation

- This view was propounded by **Peter Mitchell** in **1961** in relation to mitochondria and chloroplast. He was awarded the Nobel Prize for Chemistry in 1978 for his contribution in understanding of biological energy transfer through the formulation of chemiosmotic theory.
- According to this view, electron transport, both in respiration and photosynthesis produces a **proton gradient**. The gradient develops in the outer chamber or intermembrane space of mitochondria and inside the thylakoid lumen in chloroplasts.
- Lumen of thylakoid becomes enriched with H^+ ion due to photolytic splitting of water.
- Primary acceptor of electron is located on the outerside of thylakoid membrane. It transfers its electrons to a proton-carrier. The carrier removes a proton from stroma while transporting electron to the innerside of membrane.
- The proton is released into the lumen while the electron passes to the next carrier.
- NADP reductase is situated on the outerside of thylakoid membrane. It obtains electron from PS I and protons from matrix to reduce $NADP^+$ to $NADPH + H^+$.
- The consequences of the three events is that concentration of protons decreases in matrix or stroma region while their concentration in thylakoid lumen rises resulting in decrease in pH.
- A proton gradient develops across the thylakoid. The proton gradient is broken down due to movement of protons through transmembrane channels, CF_0 of ATPase ($CF_0 - CF_1$ particle).
- The rest of the membrane is impermeable to H^+. CF_0 provides facilitated diffusion to H^+ or protons. As protons move to the other side of ATP synthase, they bring about conformational changes in CF_1 particle of ATPase or coupling factor.
- The transient CF_1 particle of ATPase enzyme form ATP from ADP and inorganic phosphate. Therefore, ATP synthesis through chemiosmosis requires a membrane, a proton pump, a proton gradient and $CF_0 - CF_1$ particle or ATPase. For each ATP produced, $2H^+$ passes through F_0 from the intermembrane space to the matrix down the electrochemical proton gradient.

BIOSYNTHETIC PHASE (DARK REACTION)

- The products of light reaction are **ATP, NADPH** and **oxygen.** Of these, oxygen diffuses out of the chloroplast, while ATP and NADPH are used to drive the processes leading to the **synthesis of food,** more accurately, **sugars.** This is the **biosynthetic phase** of photosynthesis.
- Dark reaction was first of all established by **F.F. Blackman** (1905) and later on studied in detail by **Dr. Calvin, Benson** and **J. Bassham** and for this work they were awarded Nobel Prize (1961).
- Dark reaction will continue in the dark until the supply of ATP + NADPH is exhausted.
- Biosynthetic or dark phase occurs in **stroma** or **matrix of chloroplast**, as all the enzymes required for the process are present there.
- There are two types of pathways for the biosynthetic or dark phase – **Calvin cycle** and **C_4 cycle (Hatch Slack pathway).**
- There is a third pathway also, **CAM metabolism** which is intermediate between the two.
- The plants exhibiting Calvin cycle and C_4 dicarboxylic acid pathway are called **C_3** and **C_4** plants respectively.

Calvin Cycle

- Carbon dioxide fixation, in the presence of ATP and NADPH, and its conversion to glucose, through a series of reactions, catalysed by specific enzymes is termed as **Calvin cycle.**
- The cycle was discovered by **Calvin, Benson** and their colleagues in California, U.S.A.
- Calvin cycle or photosynthetic carbon reduction (PCR) cycle is divided into the following three phases :
  - **carboxylation**
  - **glycolytic reversal** or **reduction phase** and
  - **regeneration of RuBP.**

Hatch Slack Pathway or C_4 Cycle

- **Kortschak, Hartt** and **Burr** (1965) reported that rapidly photosynthesising sugarcane leaves produce a 4-C compound like aspartic acid and malic acid as a result of carbon dioxide fixation.

TRIO

The same THREE LETTERS will complete these four words.

Can you find the three-letter sequence?

ETHY– – – E

COE– – – TERATA

POL – – –

– – –TICEL

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Winners' names will be published in next issue.

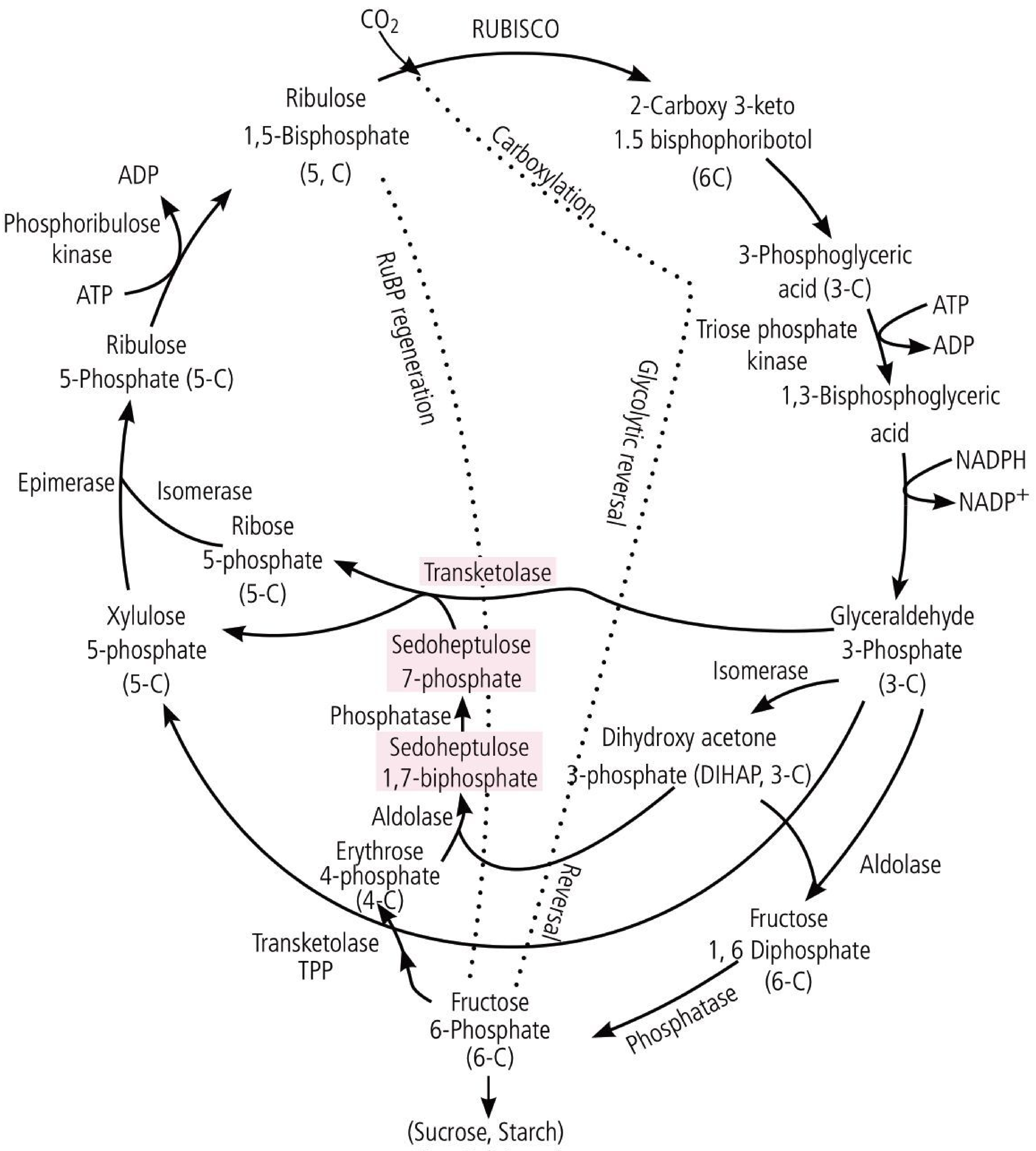

CO2
RUBISCO
Ribulose
1,5-Bisphosphate
(5, C)
2-Carboxy 3-keto
1.5 bisphophoribotol
(6C)
Carboxylation
ADP
Phosphoribulose
kinase
ATP
RuBP regeneration
Glycolytic reversal
3-Phosphoglyceric
acid (3-C)
ATP
Triose phosphate
kinase
ADP
1,3-Bisphosphoglyceric
acid
Ribulose
5-Phosphate (5-C)
NADPH
NADP+
Epimerase
Isomerase
Ribose
5-phosphate
(5-C)
Transketolase
Glyceraldehyde
3-Phosphate
(3-C)
Xylulose
5-phosphate
(5-C)
Sedoheptulose
7-phosphate
Isomerase
Phosphatase
Sedoheptulose
1,7-biphosphate
Dihydroxy acetone
3-phosphate (DIHAP, 3-C)
Aldolase
Erythrose
4-phosphate
(4-C)
Reversal
Aldolase
Fructose
1, 6 Diphosphate
(6-C)
Transketolase
TPP
Fructose
6-Phosphate
(6-C)
Phosphatase
(Sucrose, Starch)

Fig.: Calvin cycle

- This was later supported by **M.D. Hatch** and **C.R. Slack** (1966) and they reported that a 4-C compound oxaloacetic acid (OAA) is the first stable product in carbon dioxide reduction process.
- This led to an alternative pathway of carbon dioxide fixation, which is known as **Hatch Slack pathway** or C_4 cycle (as 4-C compound is the first stable product) or HSK pathway.
- All known C_4 plants are angiosperms and these are common in moist, hot, arid and nonsaline or saline habitats.
- These C_4 plants have a characteristic leaf anatomy called **kranz anatomy** (*wreath* or ring).
- The vascular bundles are surrounded by sheath of large parenchymatous cells called **bundle sheath cells,** which are in turn surrounded by **mesophyll cells.**
- In C_4 plants, there occur **2 carboxylation reactions**, first in mesophyll chloroplast and second in bundle sheath chloroplast.
- Carbon dioxide acceptor molecule is **PEP (phosphoenol pyruvate)** and not RuBP. Further, **PEP-carboxylase** or **PEPcase** is the key enzyme. (RuBP-carboxylase enzyme is negligible or absent in mesophyll chloroplast).

Crassulacean Acid Metabolism (CAM)

- This metabolism was first of all reported in *Bryophyllum* sp, a member of Family **Crassulaceae** and hence is called crassulacean acid metabolism. This occurs mostly in **succulents** (xerophytes) like *Opuntia, Agave, Aloe, Sedum, Kalanchoe*, etc.
- The most characteristic feature of these plants is that their stomata remain open at night (in dark) but remain closed during the day (in light). Thus, CAM is a kind of adaptation in succulents to carry out photosynthesis without much loss of water.
- In these plants, there is no kranz anatomy, but there occurs **dark acidification,** *i.e.*, during night malic acid is formed.
- In CAM plants, **OAA** (oxaloacetic acid) is formed due to carboxylation as in C_4 plants.

WHO AM I ...

"I am a photosynthetic pigment, hydrocarbon in nature having conjugate double bonds with a general formula of $C_{40}H_{56}$."

...search me ☺

- Thus, OAA is reduced to **malic acid**, and is accumulated in the vacuole.
- In night, carbon dioxide is absorbed from outside and with the help of PEP carboxylase, it is immediately fixed.
- Absorption of carbon dioxide during night and its storage as organic acid (malic acid) is called **acidification**.
- During daytime, malic acid undergoes oxidative decarboxylation and carbon dioxide is released.
- Liberation of carbon dioxide from an organic acid during daytime is called **deacidification**.
- The diurnal acidification and deacidification during the night and daytime respectively is called **CAM (Crassulacean Acid Metabolism).**

Photorespiration

- Photorespiration occurs in **chloroplast**. Peroxisome and mitochondrion are required for completing the process.
- The process of photorespiration is cyclic. It is also called **photosynthetic carbon oxidative** or **PCO cycle**.
- Ribulose biphosphate carboxylase (RuBisCO), the main enzyme of Calvin cycle that fixes carbon dioxide, acts as ribulose biphosphate oxygenase under low atmospheric concentration of carbon dioxide and increased concentration of oxygen.
- Photorespiration is a highly wasteful process. It consumes energy and there is 25% loss of fixed CO_2.
- Photorespiration is closely related to carbon dioxide compensation point. It usually occurs only in those plants, which have comparatively high carbon dioxide compensation point (C_3 plants).

FACTORS AFFECTING PHOTOSYNTHESIS

- There are several external and internal factors which affect the rate of photosynthesis.
- External factors include, light, temperature, carbon dioxide, water, oxygen and pollutants. Internal factors include chlorophyll, protoplasmic factor, amount of stored food in the leaf, anatomy of leaf, etc.
- **F. F. Blackman** (1905) established law of limiting factors on the basis of factors affecting photosynthesis.
- This law states that, when a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of the slowest factor (*i.e.*, factor present in minimum amount).

Carbon dioxide

- Carbon dioxide concentration of the atmosphere is 0.036% or 360 ppm. Increase in its concentration upto 0.05% increases the rate of photosynthesis in most C_3 plants, a decline is observed beyond 0.1%.
- When carbon dioxide concentration is reduced, there comes a point at which illuminated plant parts stop absorbing carbon dioxide from their environment. It is known as **carbon dioxide compensation point** or **threshold value.** The value is **25-100 ppm in C_3 plants** and **0-10 ppm in C_4 plants**.

Light

- Plants are broadly classified into two groups depending upon their inability or ability to tolerate high **light intensity** - shade plants (sciophytes, *e.g.*, *Oxalis*) and sun plants (heliophytes, *e.g.*, *Dalbergia*).
- Shade plants grow in poorly illuminated conditions, as below the canopy of tall plants, while sun plants grow in the open.
- The light intensity at which a plant can achieve maximum rate of photosynthesis is called **light saturation point**. Its value is **800-1000 ft candles** (10% of full sunlight) **in shade plants, 50-70% of full sunlight in C_3 sun plants** and upto **200% of full sunlight in C_4 sun plants**.

Temperature

- Temperature does not influence photochemical phase of photosynthesis (light reaction) but affects the biochemical phase (dark reactions).
- The optimum temperature is **10-25°C for C_3 plants** and **30-45°C for C_4 plants**.
- When temperature is increased from minimum to optimum, the rate of photosynthesis doubles for every 10°C rise in temperature.

Oxygen

- C_3 plants show optimum photosynthesis at low oxygen concentration. It is due to the reason that oxygen results in oxidation of photosynthetic pigments, intermediates and enzymes, in the presence of strong light **(photo-oxidation).**
- Oxygen competes with carbon dioxide for reducing power. This effect is not known in C_4 plants. It also converts RuBP-carboxylase to RuBP oxygenase.
- At a very high oxygen content, the rate of photosynthesis begins to decline in all plants. The phenomenon is called **Warburg effect**.

Water

- Water supplies H^+ and electrons for carbon dioxide fixation. The amount of water used in photosynthesis is very small, less than 1%. The rate of photosynthesis falls in water deficient soils.

INTEXT PRACTICE QUESTIONS

3. What is quantum yield ?
4. What are the different electron carriers in non-cyclic photophosphorylation?
5. How many carboxylation reactions occur in C_4 plants?

Respiration in Plants

- Respiration is a vital, energy yielding, enzymatically controlled catabolic process which involves a stepwise oxidative breakdown of food substance inside living cells.
- The exchange of respiratory gases, *i.e.*, O_2 and CO_2 between the organism and its surroundings is known as **external respiration** and the exchange of respiratory gases between tissue cells and surrounding environment is called **internal respiration**.
- The actual respiration by which chemical energy or bond energy of organic molecules is released by oxidation is called **cellular respiration**.

CELLULAR RESPIRATION

- Cellular respiration uses glucose and oxygen to produce carbon dioxide, water and energy.
- This released energy is used to synthesise energy rich molecules called **ATP**.
- The overall general reaction for cellular respiration can be represented as:

  $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 686$ kcal energy.

Respiratory Substrates

- The organic substances that are oxidised during respiration to liberate energy in living cells are called as respiratory substrates. The commonly used respiratory substrates are carbohydrates, proteins, fats and organic acids.
- The most common respiratory substrate is **glucose**.
- Proteins are rarely used in respiration, *e.g.*, during germination of protein rich seeds and spores.

Respiratory Quotient

- Respiratory quotient (R.Q.) is the ratio of volume of carbon dioxide liberated in respiration to the volume of oxygen consumed in it over a specific period of time by a unit tissue, organ or organisms. The ratio is expressed as:

$$\text{R.Q.} = \frac{\text{Volume of } CO_2 \text{ liberated}}{\text{Volume of } O_2 \text{ consumed}}$$

- Respiratory quotient can be unity (carbohydrate, during aerobic respiration), more than unity (organic acids), less than unity (fats, proteins), zero and infinity (carbohydrate, during anaerobic respiration).

TYPES OF RESPIRATION

- Respiration can be studied under two major categories - aerobic and anaerobic.

WHO AM I ...

"I am the fourth complex in electron transport chain involved in terminal oxidation"

...search me ☺

- **Aerobic respiration** is that type of respiration in which organic food is completely oxidised with the help of oxygen (as terminal oxidant) into carbon dioxide and water.
- It occurs by two methods : **common pathway and pentose phosphate pathway**. The common pathway of aerobic respiration takes place in three steps - **glycolysis, Krebs' cycle and terminal oxidation**.
- **Anaerobic respiration** is an enzyme mediated catabolic process where oxygen is not used as an oxidant and the organic food is broken down incompletely to liberate energy. The commonly produced products of anaerobic respiration are CO_2, ethyl alcohol and lactic acid.

GLYCOLYSIS

- It is the first stage of breakdown of glucose, common to both aerobic respiration and anaerobic respiration.
- It occurs in cytosol and involves partial oxidation of glucose into two molecules of pyruvic acid through a series of enzyme mediated reactions.
- It is also called **EMP pathway**, since it was discovered by three German scientists - Gustav Embden, Otto Meyerhof and J. Parnas in 1930.
- Glycolysis has two phases, **preparatory** and **pay off**. In the preparatory phase, glucose is broken down to glyceraldehyde 3-phosphate consuming ATP. In the pay off phase, the latter is changed into pyruvate producing NADH and ATP.

Net products of glycolysis

- In glycolysis, two molecules of ATP are consumed during double phosphorylation of glucose to form fructose-1, 6 biphosphate, while four molecules of ATP are produced by substrate level phosphorylation. Hence, there is a gain of 2 ATP molecules.
- Two molecules of NADH are formed at the time of oxidation of glyceraldehyde 3-phosphate to 1, 3- biphosphoglycerate.
- Since each NADH is equivalent to 3ATP, 6 more ATP molecules are formed. Thus, a total of 10 ATP molecules are produced and the net gain of ATP in glycolysis is 8 ATP molecules.
- The net reaction of glycolysis is as follows:

$$\text{Glucose} + 2NAD^+ + 2ADP + 2H_3PO_4 \longrightarrow 2\text{ Pyruvate} + 2NADH + 2H^+ + 2ATP$$

Significance

- First enzymatic breakdown of glucose and formation of two molecules of pyruvic acid.

- Intermediates of glycolysis are used for synthesis of important biochemicals. For example, phosphoenolpyruvate yields shikimic acid which is used in synthesis of amino acids, tryptophan, tyrosine and phenylalanine.
- Tryptophan is raw material for IAA synthesis. The amino acids are employed for synthesis of proteins, alkaloids, flavonoids and lignin. Similarly, pyruvic acid forms amino acid alanine.

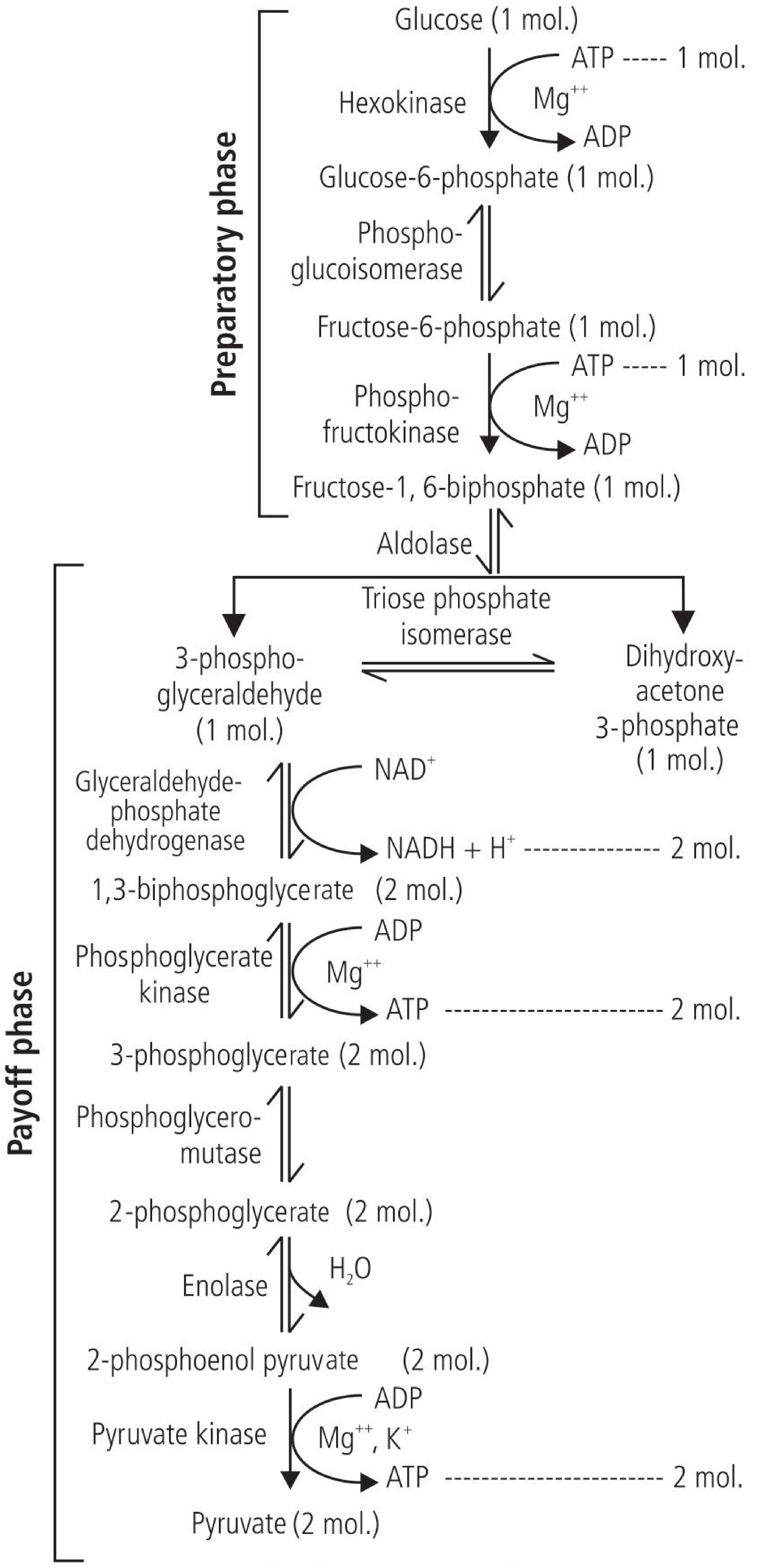

Preparatory phase
Glucose (1 mol.)
ATP ----- 1 mol.
Hexokinase
Mg⁺⁺
ADP
Glucose-6-phosphate (1 mol.)
Phospho-glucoisomerase
Fructose-6-phosphate (1 mol.)
ATP ----- 1 mol.
Phospho-fructokinase
Mg⁺⁺
ADP
Fructose-1, 6-biphosphate (1 mol.)
Aldolase
Payoff phase
Triose phosphate isomerase
3-phospho-glyceraldehyde (1 mol.)
Dihydroxy-acetone 3-phosphate (1 mol.)
Glyceraldehyde-phosphate dehydrogenase
NAD⁺
NADH + H⁺ -------------- 2 mol.
1,3-biphosphoglycerate (2 mol.)
Phosphoglycerate kinase
ADP
Mg⁺⁺
ATP ---------------------- 2 mol.
3-phosphoglycerate (2 mol.)
Phosphoglycero-mutase
2-phosphoglycerate (2 mol.)
Enolase
H₂O
2-phosphoenol pyruvate (2 mol.)
Pyruvate kinase
ADP
Mg⁺⁺, K⁺
ATP ---------------------- 2 mol.
Pyruvate (2 mol.)

Fig. : Glycolysis or EMP-pathway

Oxidation of Pyruvate : The Link Reaction

- Pyruvate formed at the end of glycolysis does not enter the next step of citric acid cycle directly. Rather, it is transported from cytoplasm to mitochondria through a specific transport protein.
- Pyruvate undergoes oxidative decarboxylation to produce CO_2 and NADH. The resultant product combines with sulphur containing coenzyme A to form acetyl CoA, in the presence of enzyme complex pyruvate dehydrogenase.

$$\text{Pyruvate} + \text{NAD}^+ + \text{CoA} \xrightarrow[\text{Mg}^{2+}]{\text{Pyruvate dehydrogenase}} \text{Acetyl CoA} + \text{NADH} + \text{H}^+ + \text{CO}_2$$

KREBS' CYCLE

- Citric acid cycle or Krebs' cycle is the next step of glycolysis linked by pyruvate oxidation. Krebs' cycle was proposed by **Hans Adolf Krebs** in 1937. It operates in the mitochondrial matrix.
- The cycle consists of 10 enzymatic steps, four of which are dehydrogenations and two decarboxylations.
- Oxaloacetate released at end picks up another molecule of activated acetate to repeat the cycle, as two molecules of acetyl-CoA are formed from one molecule of glucose. Therefore, net gain of Krebs' cycle is :
- $2\text{ Acetyl-CoA} + 6H_2O + 6\text{NAD}^+ + 2\text{FAD} + 2\text{GDP} + 2\text{Pi} \rightarrow 4CO_2 + 2H_2O + 6\text{NADH} + 6H^+ + 2\text{FADH}_2 + 2\text{GTP} + 2\text{ CoA}$
- During the process of oxidation of 2 acetyl CoA *via* Krebs' cycle, 8 reducing equivalents (6 as NADH and 2 as $FADH_2$) are produced.
- Being catabolic, Krebs' cycle provides a number of intermediates which are used in different anabolic pathways to form important biomolecules like glutamic acid, aspartic acid, etc., hence this cycle is amphibolic in nature.

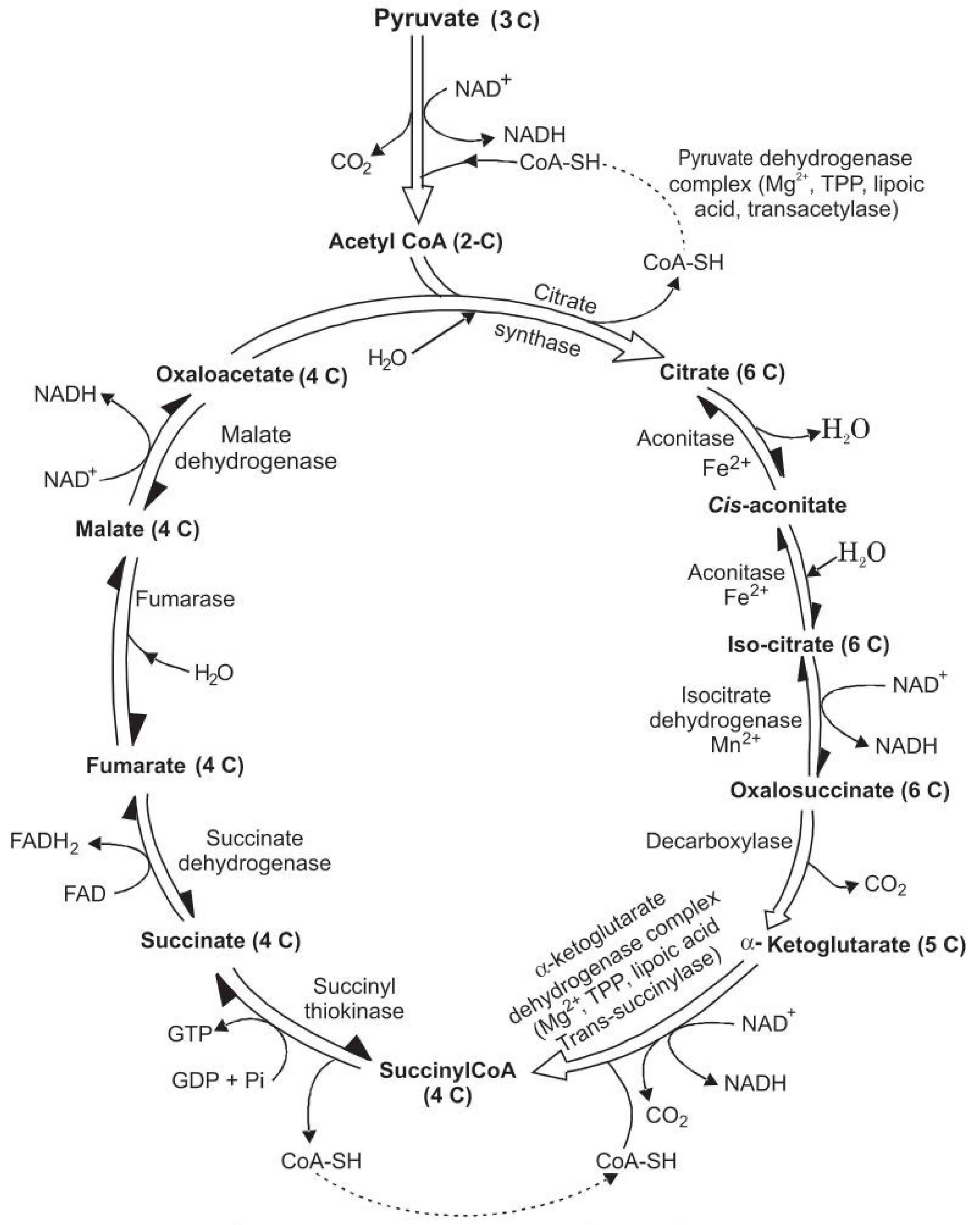

Pyruvate (3 C)
NAD⁺
NADH
CO₂
CoA-SH
Pyruvate dehydrogenase complex (Mg²⁺, TPP, lipoic acid, transacetylase)
Acetyl CoA (2-C)
CoA-SH
Citrate synthase
H₂O
Oxaloacetate (4 C)
Citrate (6 C)
NADH
NAD⁺
Malate dehydrogenase
Aconitase Fe²⁺
H₂O
Cis-aconitate
Malate (4 C)
Aconitase Fe²⁺
H₂O
Fumarase
H₂O
Iso-citrate (6 C)
Isocitrate dehydrogenase Mn²⁺
NAD⁺
NADH
Fumarate (4 C)
Oxalosuccinate (6 C)
FADH₂
FAD
Succinate dehydrogenase
Decarboxylase
CO₂
Succinate (4 C)
α-ketoglutarate dehydrogenase complex (Mg²⁺, TPP, lipoic acid Trans-succinylase)
α- Ketoglutarate (5 C)
Succinyl thiokinase
GTP
GDP + Pi
SuccinylCoA (4 C)
NAD⁺
NADH
CO₂
CoA-SH
CoA-SH

Fig.: Schematic representation of Krebs' cycle

INTEXT PRACTICE QUESTIONS

6. What is the product of first enzymatic breakdown of glucose during aerobic respiration?

7. How many enzymatic steps are involved in citric acid cycle?

TERMINAL OXIDATION

- It is an oxidation that occurs towards the end of catabolic process and consists of two processes : electron transport and oxidative phosphorylation.

Electron transport chain

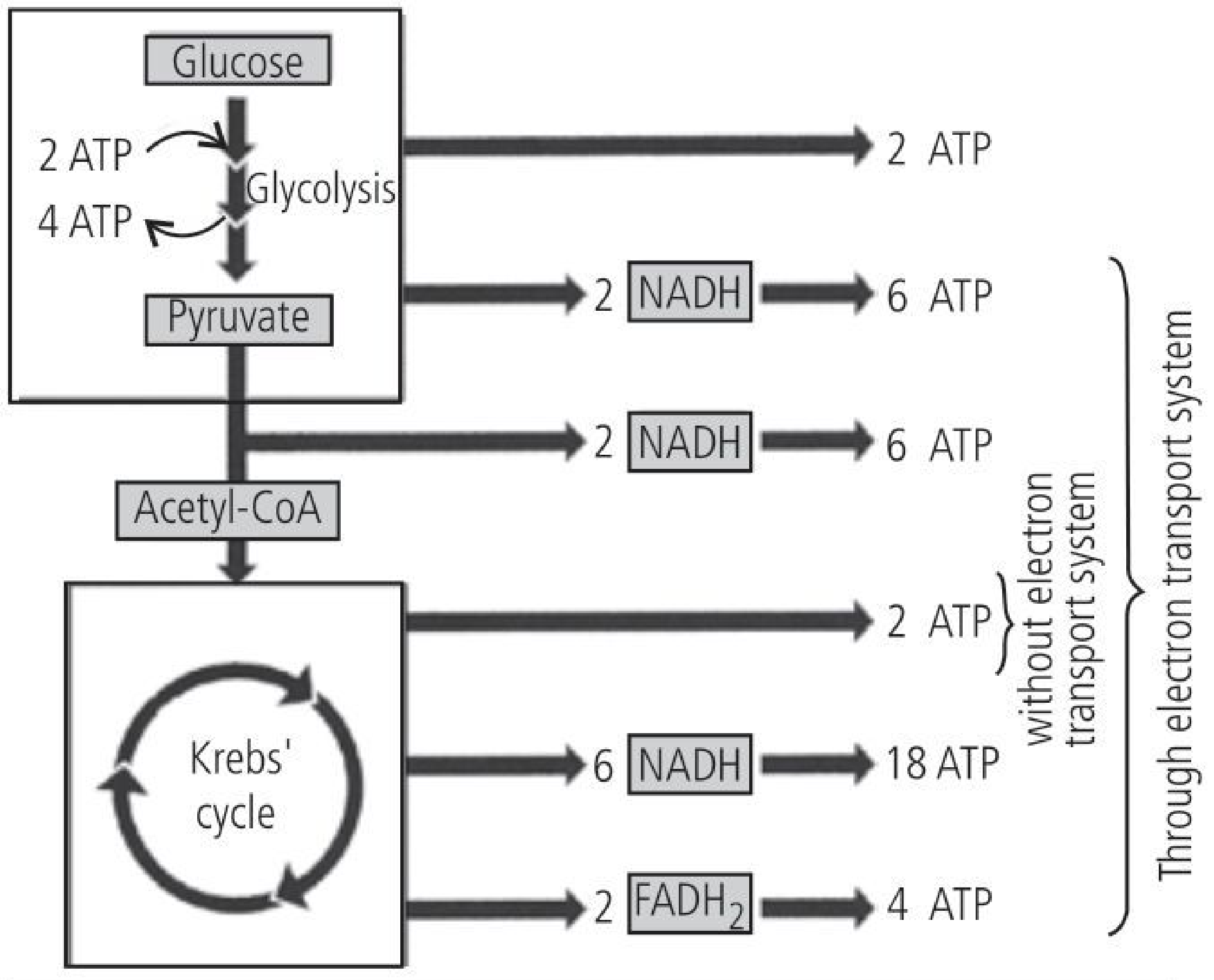
- The inner mitochondrial membrane has groups of several proton (H^+) and electron (e^-) acceptors. These groups are arranged in a specific series called electron transport chain (ETC) or electron transport system (ETS).

Table: Multiprotein complexes in electron transport chain

Complex name	Description
NADH – Coenzyme Q reductase (or NADH dehydrogenase complex)	This complex comprises **NADH dehydrogenase**, **FMN** and **FeS** centre. Two protons and two electrons from NADH + H^+ are transferred to FMN, which gets reduced to $FMNH_2$. Electrons are then transferred from $FMNH_2$ to **Coenzyme Q (CoQ)**, also called **ubiquinone (UQ)** which gets reduced to **$CoQH_2$.** During this process, $2H^+$ are transferred from the matrix side of inner membrane of mitochondrion to the intermembrane space.
Succinate – Coenzyme Q reductase (or succinate dehydrogenase complex)	It includes the membrane bound enzyme of Krebs' cycle, **succinate dehydrogenase**, **FAD** and **FeS** centre. Two hydrogens removed from succinate reduce FAD to $FADH_2$. From $FADH_2$, the electrons are transferred to CoQ *via* FeS centre and CoQ is reduced to **$CoQH_2$**.
Cytochrome *c* reductase (cytochrome bc_1 complex)	It consists of **cytochrome *b***, **FeS complex** and **cytochrome c_1**. Electrons donated by $CoQH_2$ are transferred through cyt *b*, FeS centre and cyt c_1 to cytochrome *c*, which gets reduced. 4 H^+ are transferred from matrix to intermembrane space. Like CoQ, cytochrome *c* is a mobile electron carrier and is not the part of any complex mentioned here.
Cytochrome *c* oxidase complex	It includes **cytochrome** *a*, **cytochrome** a_3 and two copper centres. Electrons are received from cytochrome *c* (which gets oxidised). Electrons are ultimately transferred to oxygen to form water. This step is called **terminal oxidation**.

Oxidative phosphorylation

- Oxidative phosphorylation is the synthesis of energy rich ATP molecules with the help of energy liberated during oxidation of reduced coenzymes (NADH, $FADH_2$) produced in respiration.
- Oxidative phosphorylation requires enzyme ATP synthase. It is considered to be the fifth complex of electron transport chain. ATP synthase is located in F_1 or head piece of elementary particles ($F_0 - F_1$) present on mitochondrial membrane.
- The protons (H^+) originating from electron transfer are translocated by the respiratory chain across the membrane from the M (matrix) side to the C (cytosol) side or outer side.
- Transport of the electrons from NADH over ETC helps in pushing three pairs of protons to the outer chamber while two pairs of protons are sent outwardly during electron flow from $FADH_2$ (as the latter donates its electrons further down to the ETC).
- According to the chemiosmotic hypothesis of Peter Mitchell, this translocation creates a pH difference and a membrane potential. Both constitute the proton-motive force that tends to move H^+ from the C side back to the M side of the membrane.
- Since the inner mitochondrial membrane is highly impermeable to H^+ ions, these can only reach the M side through the "proton channel" of the ATPase. When H^+ moves from the C side to the M side, the F_1-ATPase, operating in reverse, catalyses ATP synthesis.



Total net ATP yield =38 or 36 ATP
(Depending upon pathways of aerobic respiration)

Fig.: Summary of ATP produced

Balance Sheet of ATP

- The total ATP production obtained from complete oxidation of glucose molecule to CO_2 and H_2O under aerobic conditions is 36 or 38.

ANAEROBIC RESPIRATION

- Anaerobic respiration is an enzyme mediated energy liberating, catabolic process of step-wise but incomplete breakdown of organic substrate without using oxygen as an oxidant. Energy is liberated during breaking of bonds between various types of atoms. The common products of anaerobic respiration are CO_2, ethyl alcohol and lactic acid.

$$C_6H_{12}O_6 \xrightarrow{\text{Enzyme}} 2CO_2 + \underset{\text{(Ethyl alcohol)}}{2C_2H_5OH} + 59 \text{ kcal energy}$$

$$C_6H_{12}O_6 \xrightarrow{\text{Enzyme}} \underset{\text{(Lactic acid)}}{2C_3H_6O_3} + 36 \text{ kcal energy}$$

- In microorganisms, the term anaerobic respiration is replaced by **fermentation**. The latter is defined as anaerobic breakdown of carbohydrates and other organic compounds to form alcohol and organic acids with the help of microbes or their enzymes.

Mechanism of Anaerobic Respiration

- Glycolysis, the enzymatic breakdown of glucose into two molecules of pyruvate is common to both anaerobic and aerobic mechanism of respiration.
- Here onwards, pyruvate formed is anaerobically broken down into various products depending upon the organism and the site, *i.e.*, type of tissue where it is occurring.
- For example, alcohol is formed in fungi (*Rhizopus*, yeast), bacteria and lactic acid is formed in lactic acid bacteria, *e.g.*, *Lactobacillus*, some fungi and muscles of vertebrates.

INTEXT PRACTICE QUESTIONS

8. What are the different components of complex - I in electron transport chain?

9. Where does exactly ATP synthase located within elementary $F_0 – F_1$ particle?

Plant Growth and Development

- 'Growth' and 'development' are sometimes used interchangeably, but in botanical sense they describe separate events in the organisation of the mature plant body. Plant growth is generally indeterminate, *i.e.*, continued throughout the life.

GROWTH

- **Growth** is defined as a permanent or irreversible increase in dry weight, size, mass or volume of a cell, organ or organism. During growth, anabolic processes exceed catabolic processes. Growth is final end product of successful metabolism.
- In plants, growth is restricted to some specific regions (called **meristems**). The growing regions in plants are **apices of shoot** and **root** where meristems are present. Plant growth takes place in three steps or phases: **formative phase**, **enlargement phase** and **differentiation phase**.
- The increase in growth per unit time is called **growth rate**. It may results in two types of growth:

(i) **Arithmetic growth –** It is a type of growth in which the rate of growth is constant and increase in growth occurs in arithmetic progression, *i.e.*, 2, 4, 6, 8, etc. Here after mitosis, one daughter cell remains meristematic while, other grows and differentiates. Here, a **linear curve** is obtained on plotting growth against time.

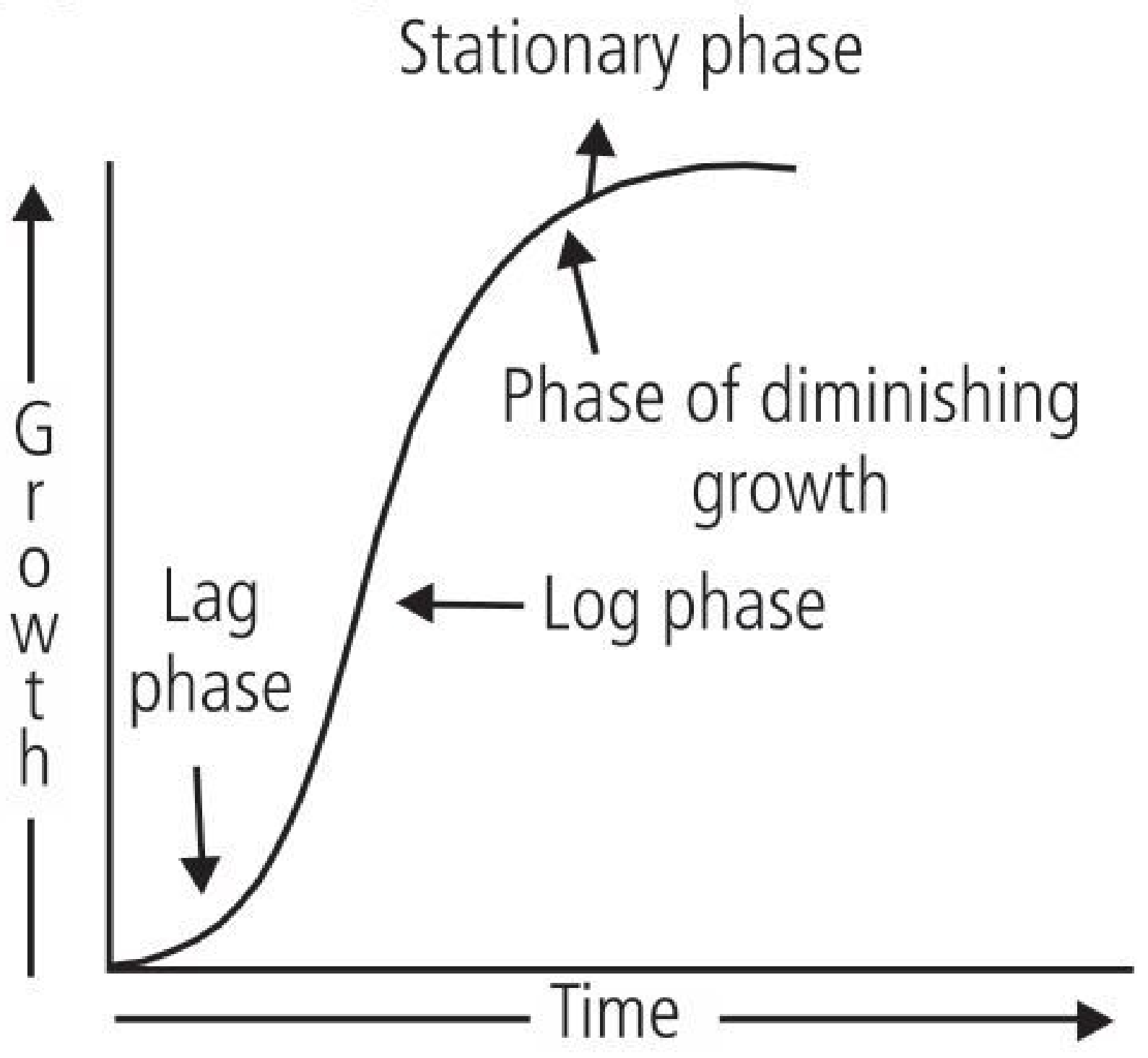


Fig.: Sigmoid growth curve

(ii) **Geometric growth –** It is quite common in unicellular organisms when grown in nutrient rich medium. Here, every cell divides. The daughter cells grow and divide and the process is repeated for generation. Initial growth is slow as the number of cells initially are small. Later on, there is rapid growth at exponential rate. It is called **log** or **exponential growth.**

- If total growth is plotted against time, an S-shaped or **sigmoid curve** is obtained. It consists of four parts – **lag** phase, **log** phase (exponential phase), **phase of diminishing growth** and **stationary** phase.
- The total growth per unit time is called **absolute growth rate.** It is the actual growth curve obtained by plotting growth against time. The growth of a system over a period of time compared to its initial growth is called **relative growth rate.** Growth is measured by measuring increase in length, *e.g.*, stem, root, pollen tube; increase in volume, *e.g.*, fruits; increase in area, *e.g.*, leaves increase in diameter, tree trunks and fruits increase in fresh or dry weight, etc.
- Various factors affect growth such as : intensity, quality and duration of sunlight; temperature; water; nutrients; gravity; carbon dioxide and oxygen.

DEVELOPMENT

- **Development** is the sequence of changes that occur in the structure and functioning of an organism, organ, tissue or cell involving its formation, growth, differentiation, maturation, reproduction, senescence and death. The ability to change under the influence of internal or external stimuli is called **plasticity.** The intrinsic plasticity is found in cotton, coriander, etc. Environmental plasticity is best seen in emergent hydrophytes like buttercup *(Ranunculus)*. In both cases, plants show heterophylly.
- **Heterophylly** is the occurrence of different types of leaves on the same plant habitually in different growth phases or under different environmental conditions.
- **Differentiation** is the permanent qualitative change in structure, chemistry and physiology of cell wall and protoplasm of cells, tissues and organs.
- **Dedifferentiation** is the process of despecialisation of differentiated living cells so that they regain the capacity to divide and form new cells. A dedifferentiated tissue can act as meristem, *e.g.*, interfascicular vascular cambium, cork cambium.
- **Redifferentiation** is the structural, chemical and physiological specialisation of cells derived from dedifferentiated meristematic cells. Secondary phloem, secondary xylem and cork cells are some of the tissues formed through redifferentiation.

PLANT GROWTH REGULATORS

- Plant growth regulators (PGR) are of diverse chemical compositions that function in low concentration and regulate plant growth, differentiation and development. **Plant hormones** or **phytohormones** are a type of PGR.
- Phytohormones are of two major types: **growth promoters** (*e.g.*, auxins, gibberellins and cytokinins) and **growth inhibitors** (*e.g.*, abscisic acid and ethylene).

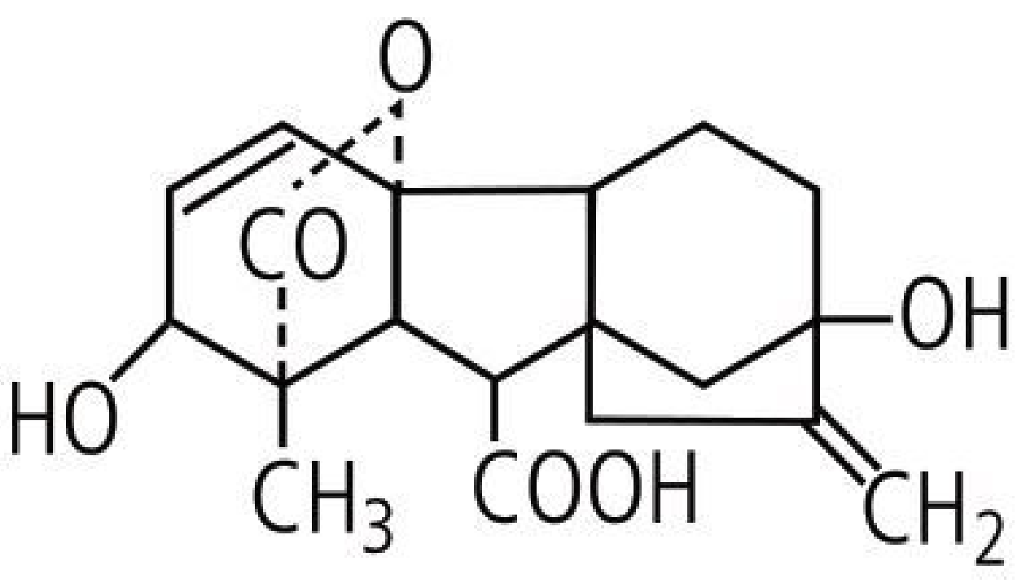
Auxins

- Auxins are weakly acidic growth hormone having an unsaturated ring structure.
- **They can be natural Indole 3 - acetic acid (IAA), Phenyl acetic acid (PAA), Indole 3- acetonitrile (INA) and synthetic (Indole 3-butyric acid, NAA, 2, 4-D, 2, 4, 5-T)** compounds having similar structure and properties.
- IAA is the universal natural auxin. It is found in shoot apices, leaf primordia and developing seeds and is synthesised from amino acid tryptophan, a precursor of IAA or auxins.
- *Avena* **curvature test** and **root growth inhibition test** are done for examining auxin effect.

Functions

- Promotes cell enlargement and division and initiates root formation on stem cuttings.
- Regulates cambial activity and xylem differentiation.
- Shows apical dominance *i.e.*, inhibits the growth of lateral buds.
- Prevents or delays abscission as well as induces synthesis of ethylene.
- Auxins **induce parthenocarpic development of fruits** and such fruits are seedless.
- Auxins **induce feminisation**, *i.e.*, on male plant, female flowers are produced.
- 2, 4-D is a famous herbicide or weedicide (especially kills broad leaved weeds). It kills weeds perhaps by over stimulated root growth.
- Auxins are responsible for phototropism and geotropism.

Gibberellin



- Gibberellin is a weakly acidic growth hormone, having gibbane ring structure.
- **Hori** and **Kurosawa** discovered the active substance from filtrate of fungus, *Gibberella fujikuroi* and named it gibberellin.
- **GA_3** was first gibberellin to be isolated in its pure form and remains the most extensively studied.
- The major sites of gibberellin production in plants are embryos, roots and young leaves near the shoot tip.
- **Mevalonic acid** (derived from acetyl Co-A) acts as precursor for synthesis of gibberellins.
- **Barley endosperm test** and **germination of dwarf pea** seeds are used as bioassays.

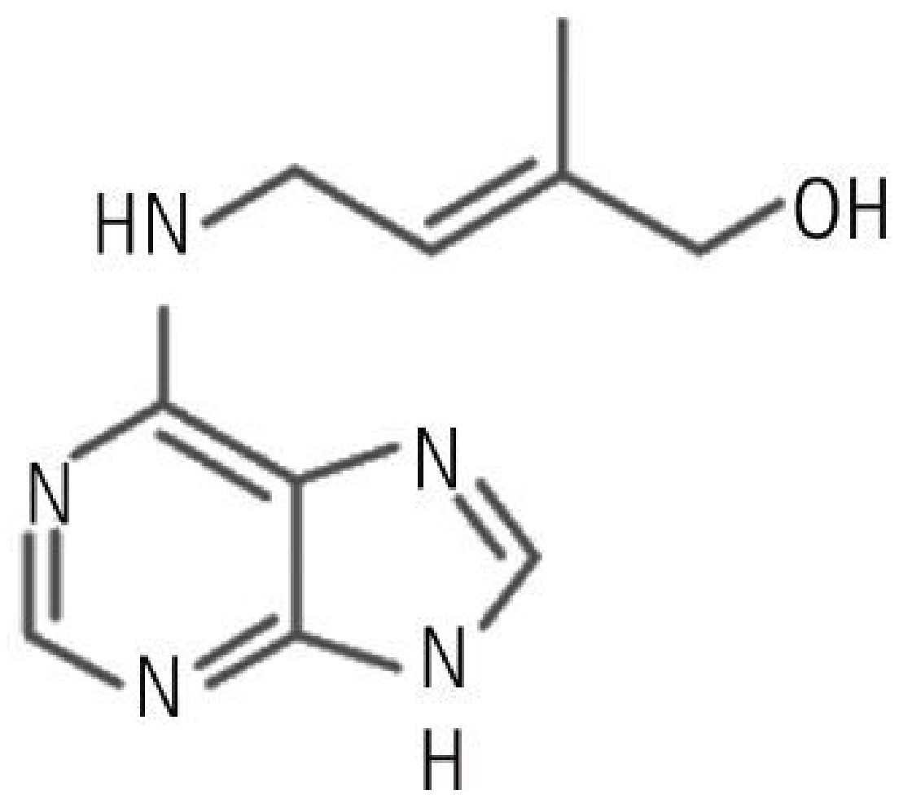
Functions

- Stimulates stem elongation and leaf expansion.
- Overcome natural dormancy of buds, tubers, seeds, etc.

- Induces elongation of reduced stem or bolting in rosette plants *e.g.*, henbane, cabbage.
- Promotes seed germination by inducing production of hydrolytic enzymes for solubilising reserve food.
- Promotes flowering in long day plants during non-inductive period.
- Controls fruit growth and development as well as induces parthenocarpy. **Gibberellic acids are more potent parthenocarpic agents than auxins**.
- Promotes formation of male flowers on female plants *e.g.*, *Cannabis*. They can also replace female flowers with male ones on monoecious plants of cucurbits.

Cytokinins

- Cytokinins are basic hormones, derivatives of either aminopurine or phenyl urea that promote cytokinesis.
- The first cytokinin was discovered from autoclaved herring sperm DNA.
- The first natural cytokinin was obtained from unripe maize grains, called zeatin (6-hydroxy 3-methyl trans 2-butenyl amino purine). It is found in coconut milk. It is mainly found in roots, however it is also synthesised in endosperm regions of seeds, growing embryos, young fruits and developing shoot buds.



- **Tobacco pith culture**, **retardation of leaf senescence** and **excised radish cotyledon expansion** are used as bioassays for cytokinins.

Functions

- Promotes cell division.
- Essential for morphogenesis and differentiation of tissues and organs.
- Delays senescence by mobilisation of nutrients.
- Overcome apical dominance caused by auxins and promote lateral bud development.
- Induces accumulation of salts inside cells and helps in phloem transport.
- Promotes femaleness in flowers.

Abscisic Acid

- Abscisic acid is a mildly acidic growth hormone which acts as a general growth inhibitor.
- It is also called **stress hormone** since its production is stimulated under conditions of drought, water logging and adverse environmental conditions.
- The hormone was first isolated by **Addicott** *et al* (1963) from cotton bolls. It is found in many parts of the plant but is more abundant in chloroplast of green cells. It is synthesised from **mevalonic acid** or **xanthophyll.**
- **Rice seedling growth inhibition test** and **inhibition of α-amylase synthesis in barley endosperm** are used as bioassay.

Functions

- Induces dormancy of buds, seeds and underground stems, hence also called **dormin**.
- Promotes abscission of flowers and fruits.
- Induces senescence of leaves by promoting degradation of chlorophyll and proteins.
- Inhibits seed germination by inhibiting gibberellin mediated amylase formation.
- It is **antagonist** to gibberellin and counteracts the effect of growth promoting hormones-auxins and cytokinins.
- Used as **antitranspirant,** as application of even minute quantities of ABA on leaves causes partial closure of stomata.
- Induces flowering in some short day plants, even under unfavourable photoperiods.
- External application on stem cuttings initiate rooting.

Ethylene

- Ethylene is the only **gaseous phytohormone** which stimulates transverse or isodiametric growth but retards the longitudinal one.
- It is found in almost all parts of plants in minimal amount but maximum production occurs during ripening of fruits and in tissues undergoing senescence. It is synthesised from amino acid methionine in plants.
- The **'triple response' of etiolated pea plant** and **gas chromatographic** assay are used as bioassays.

Functions

- Promotes apical dominance and prolongs dormancy of lateral buds but breaks the dormancy of buds, seeds and storage organs.
- Induces abscission and senescence of various parts *i.e.*, leaves, flowers and fruits.
- Induces epinasty, a phenomenon which decreases the sensitivity to gravity.
- Helps in root initiation, growth of lateral roots and root hairs.
- Stimulates flowering in pineapple and other related plants and helps in synchronising fruit set.
- Induces ripening of fleshy climacteric fruits and dehiscence of dry

WHO AM I ...

"I am an universal natural growth regulator of plant and I am synthesised from tryptophan."

...search me ☺

fruits. Ethylene lamps are used for ripening of fleshy fruits *e.g.*, banana, mango, apple, tomato.

- Ethylene is used to induce feminising effect *e.g.*, number of female flowers and thus fruits in cucumber.

Intext Practice Questions

10. What do you understand by absolute growth rate?
11. Which tests confirm the effect of auxin in plant growth?
12. How does ABA acts as antitranspirant?

SEED GERMINATION

- Seed germination is the activation and growth (rejuvenation) of the embryo into a seedling during favourable conditions. It may be epigeal (cotyledons are pushed out of the soil) and hypogeal (cotyledons do not come out of the soil).
- Seeds which germinate only in presence of light are called **photoblastic seeds**. The capacity of a seed to germinate and develop into a seedling is called **seed viability**.

PHOTOPERIODISM

- **Photoperiodism** is the effect of photoperiods or daily duration of light hours (and dark periods) on the growth and development of plants, especially flowering. Photoperiodism was first studied by **Garner** and **Allard** (1920) in 'Maryland mammoth' variety of tobacco.
- **Long day plants** (LDPs) flower when they receive long photoperiods or light hours which are above a critical length, *e.g.*, henbane (*Hyoscyamus niger*), wheat, oat, sugar beet, spinach (*Spinacia oleracea*), radish, barley, larkspur, lettuce, etc.
- **Short day plants** (SDPs) flower when photoperiod is less than critical day length, *e.g.*, *Nicotiana tabacum*, *Glycine max* (soybean), *Xanthium strumarium* (cocklebur), *Cannabis sativa*, etc.
- **Day neutral plants** (DNPs) are invariable of the day length. They flower at about the same time under all day lengths, *e.g.*, *Cucumis sativus*, *Gossypium hirsutum*, *Pisum sativum*, etc.
- **Long short day plants** (L-SDPs) require long photoperiods for floral initiation and short photoperiods for blossoming. The plants flower between summer and autumn, *e.g.*, *Bryophyllum*, *Cestrum*.
- **Intermediate day plants** (IDPs) flower within a definite range of light hours. Flowering does not take place above and below this range, *e.g.*, wild kidney bean.
- **Short-long day plants** (S-LDPs) require short photoperiods for initiation of flowering and long photoperiods for blossoming, *e.g.*, *Campanula medium* and petkus variety of rye.

VERNALISATION

- Vernalisation is the process of shortening of the juvenile or vegetative phase and hastening flowering by a previous cold treatment. In vernalisation by cold treatment, winter varieties are transferred into spring or summer varieties.
- Site of vernalisation is **apical meristem** or all the **meristematic cells**, *e.g.*, shoot tip, embryo tips, root apex, etc. As a result of vernalisation, a flowering hormone called **vernalin** is formed (reported by Melchers), but vernalin has never been isolated. Once a plant is vernalised, it can be devernalised by exposing the plant to temperature of 30°C or above. For establishing vernalisation, plant should be kept at low temperature for 4-5 days depending upon the species.
- Vernalisation has advantages like crops can be grown earlier as juvenile or vegetative period is shortened and brings about early flowering. Plants can be grown in such regions where normally they do not grow. Yield of the plant is increased.

SEED DORMANCY

- In majority of plants, seeds remain in an inactive state and germinate only after a specific period of rest. Such inactive state is called **dormancy** or **quiescence**. Dormancy may be defined as, "the inactive state of the seed in which growth of the embryo is temporarily suspended for a specific length of time".

Intext Practice Questions

13. What would happen to spinach if it gets shorter light hours below its critical light period?
14. What are photoblastic seeds?

Scientist of the Month

Alfred Russel Wallace

(January 8, 1823-November 7, 1913)

Early life and Education :

Alfred Wallace was a notable English naturalist, evolutionist, geographer, anthropologist and the co-discoverer with Charles Darwin of the theory of evolution and natural selection. He was born in a village near Usk, Monmouthshire, Wales, UK. He was the seventh of nine children of Thomas Vere Wallace and Mary Anne Greenell. Wallace had no formal training as a biologist and did not go to university. After leaving school he worked at his brother's surveying firm where he trained and worked as a land surveyor. Working outdoors, Wallace grew interest in the natural world and began collecting insects. Later, he found a teaching work at the Collegiate School in Leicester. While working as a teacher, he met an accomplished entomologist, Henry Walter Bates, who persuaded him to collect insects for research purposes. Together they planned an expedition to the Amazon and left for Brazil in 1848.

Wallace and Bates started their journey to Brazil in search of insects and other animal specimens in the Amazon rainforest. After four years of successful expedition and with a wide collection of specimens, on his way back to UK in 1852, the ship's cargo caught fire and most of the gatherings and precious items were lost. The crew was rescued but he only managed to save a part of his diary and a few sketches from his voyage.

In 1854, he started another voyage through the Malay Archipelago or East Indies to study natural history and collect other specimens. While on his exploration, he developed his famous insight on theory of evolution through natural selection. In 1858, an article on his insights was published along with a description of the famous Darwin's theory.

He became a public figure in England during the second half of the 19th century, known for his courageous views on scientific, social, and spiritualist subjects. His formulation of the theory of evolution by natural selection, which predated Charles Darwin's published contributions, is his most outstanding legacy.

He died on November 7, 1913 at his home in Broadstone, Dorset, England, at the age of 90. He was buried in the small cemetery at Broadstone, Dorset.

Contributions:

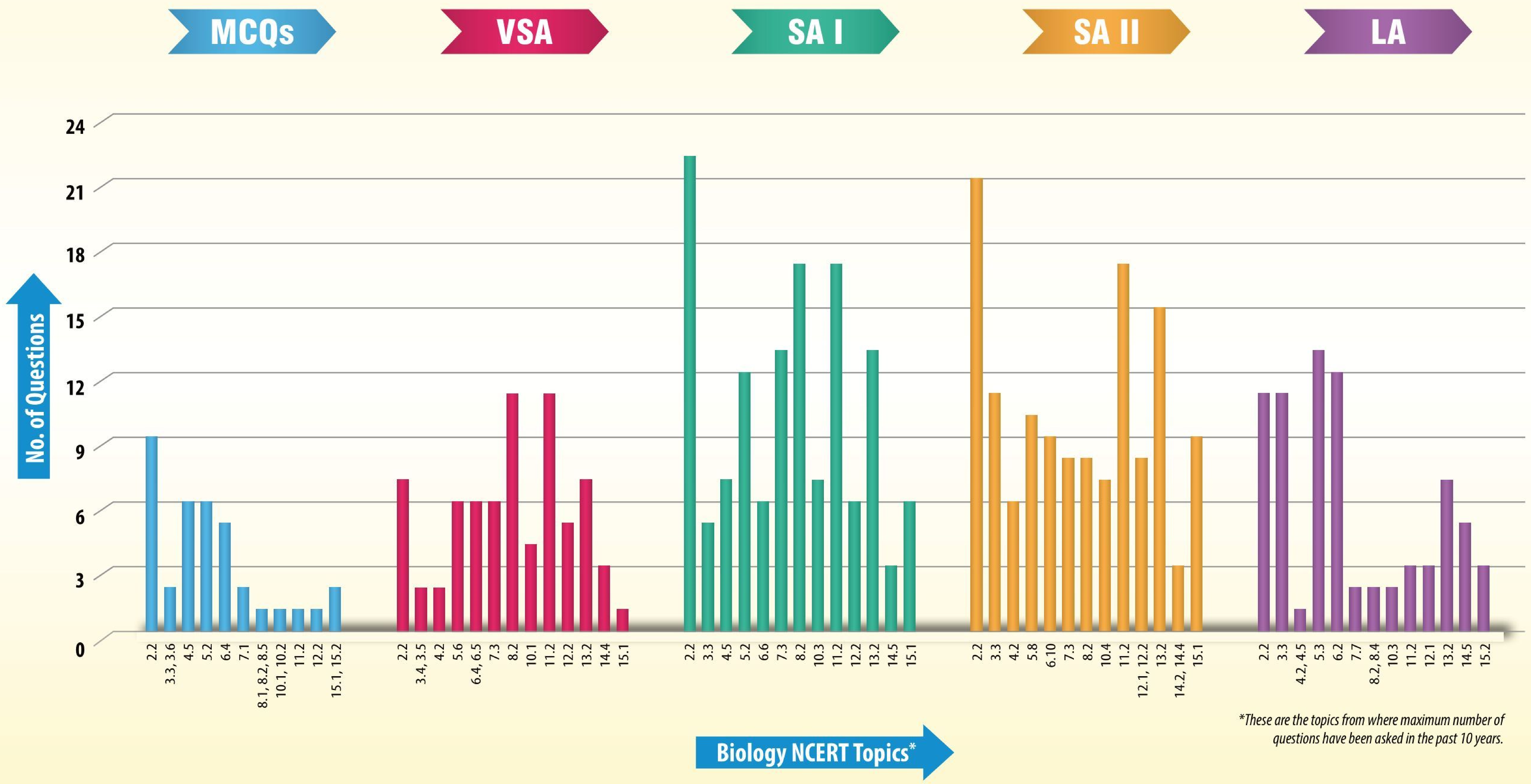
- His most prominent work was conceiving the 'theory of evolution through natural selection'. It is one of the most celebrated works in the history of evolution.
- He also performed pioneering works in biogeography and became a leading expert on the geographical distribution of animal species. The Wallace's Line is a faunal boundary line drawn in 1859 by him and named by English biologist Thomas Henry Huxley, that separates the ecozones of Asia and Wallacean, a transitional zone between Asia and Australia.
- During his Archipelago exploration over a period of eight years, he collected 1,25,660 specimens including 5,000 new species.
- 'The Malay Archipelago', an account of his studies and adventures, published in 1869, became one of the most popular books of scientific exploration of the 19th century.
- Reinforcement is a process of speciation where natural selection increases the reproductive isolation between two populations of species. This occurs as a result of selection acting against the production of hybrid individuals of low fitness. The idea was originally developed by Alfred Russel Wallace and is sometimes referred to as the Wallace effect.

Awards and Honours:

- In 1868, he was honoured with the Royal Medal by the Royal Society for his efforts in "practical and theoretical zoology".
- He was also conferred honorary doctorates from the Universities of Dublin (1882) and Oxford (1889).
- In 1892, he received the Royal Geographical Society's Founder's Medal as well as the Linnean Society's Gold Medal.
- He was awarded the Copley Medal in 1908. The same year he also became the recipient of the 'Order of Merit'.
- The Darwin–Wallace Medal is a medal awarded by the Linnean Society of London for "major advances in evolutionary biology. ☺☺

Are You Ready for CBSE Board Exams?

Past 10 Years (2013-2022) Chapterwise and Topicwise Trend Analysis of CBSE Board Questions



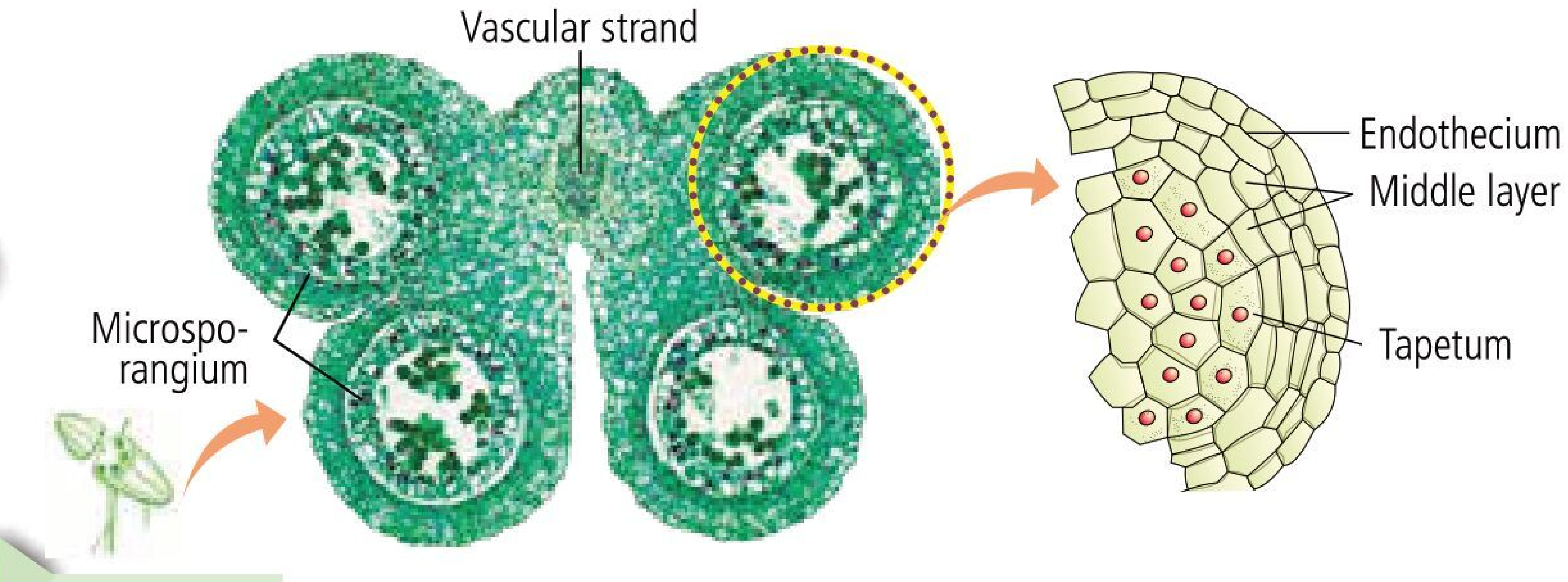
*These are the topics from where maximum number of questions have been asked in the past 10 years.

Some of the important topics extracted from the graphical analysis are explained here with HD images.

02 | Sexual Reproduction in Flowering Plants

Microsporogenesis

The process of formation of microspores from sporogenous tissue is known as microsporogenesis. It takes place inside microsporangium.


Vascular strand
Microsporangium
Endothecium
Middle layer
Tapetum

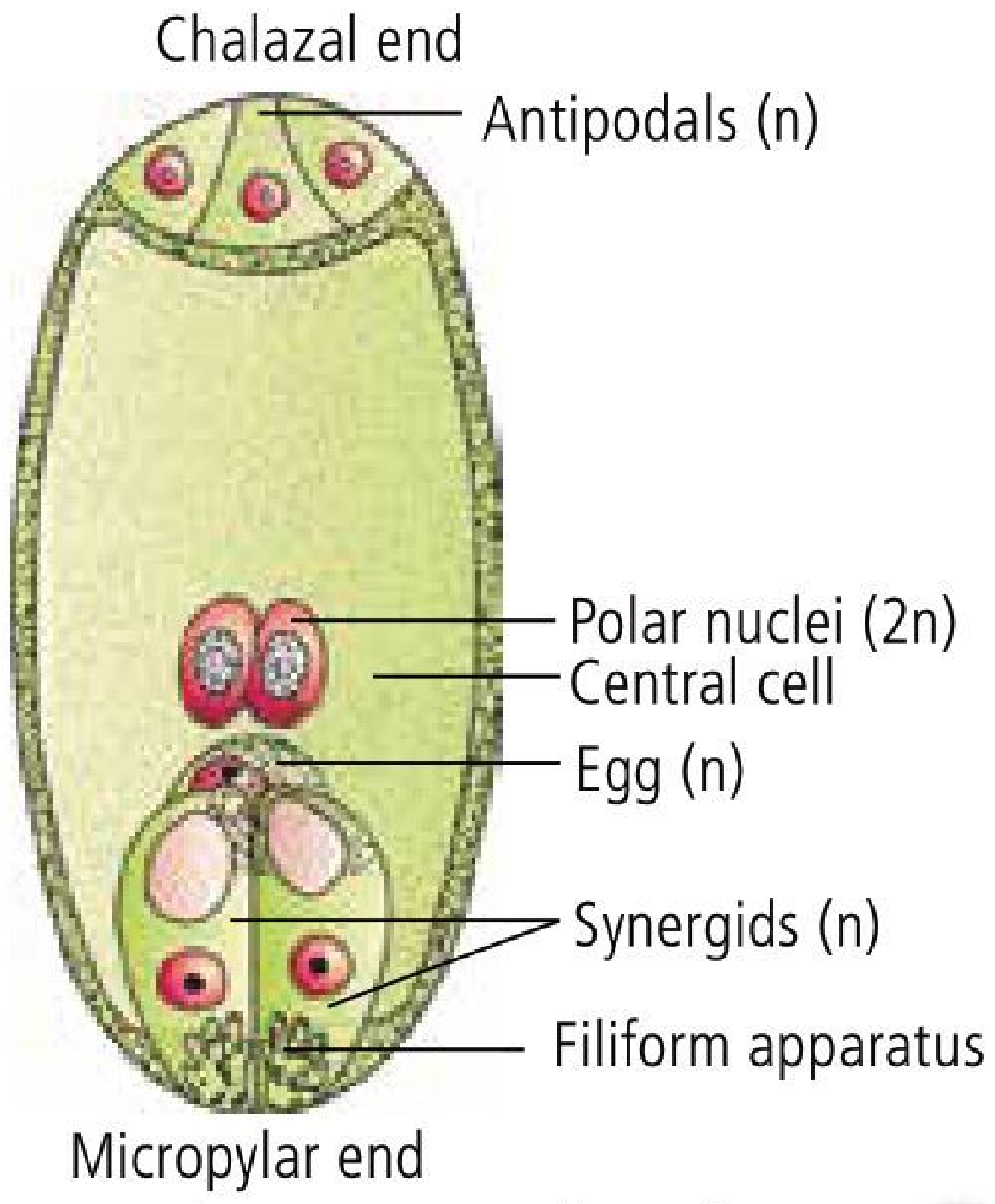
T.S. of young anther

Megasporogenesis

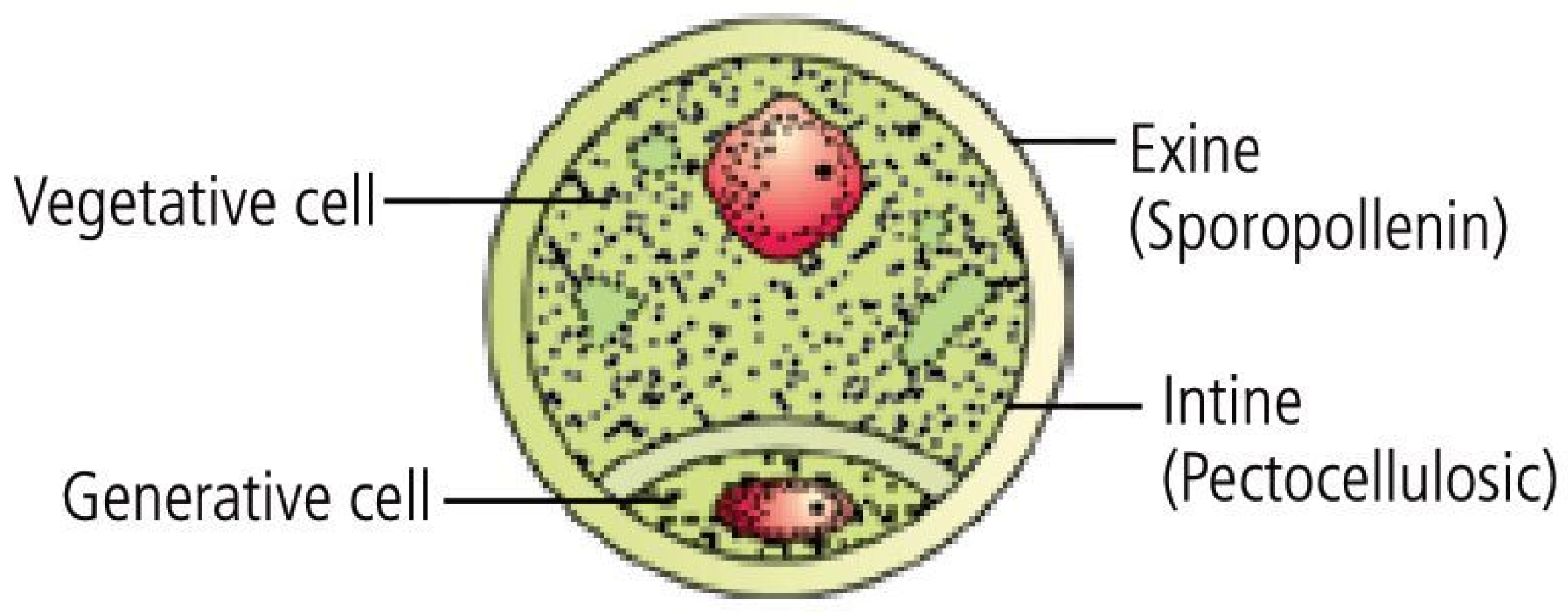
- It involves formation of haploid megaspores inside megasporangium which grows in size and divides by mitosis to form 2-nucleated cell and then **embryo sac**, the **female gametophyte**.
- 1 megaspore mother cell produces 1 functional megaspore.

Microspore

- Mature pollen grain :
  2-celled (tube cell + generative cell)
  3-celled (tube cell + two male gametes)
- 1 microspore mother cell produces 4 functional microspores.


Chalazal end
Antipodals (n)
Polar nuclei (2n)
Central cell
Egg (n)
Synergids (n)
Filiform apparatus
Micropylar end

A diagrammatic representation of the mature embryo sac


Vegetative cell
Generative cell
Exine
(Sporopollenin)
Intine
(Pectocellulosic)

Male gametophyte

Xenogamy (Cross pollination)

- Transfer of pollen grains from anther of one flower to the stigma of genetically different flower of same species.
- Also known as cross pollination or allogamy.

Autogamy

Transfer of pollen grains from anther to stigma of same flower.

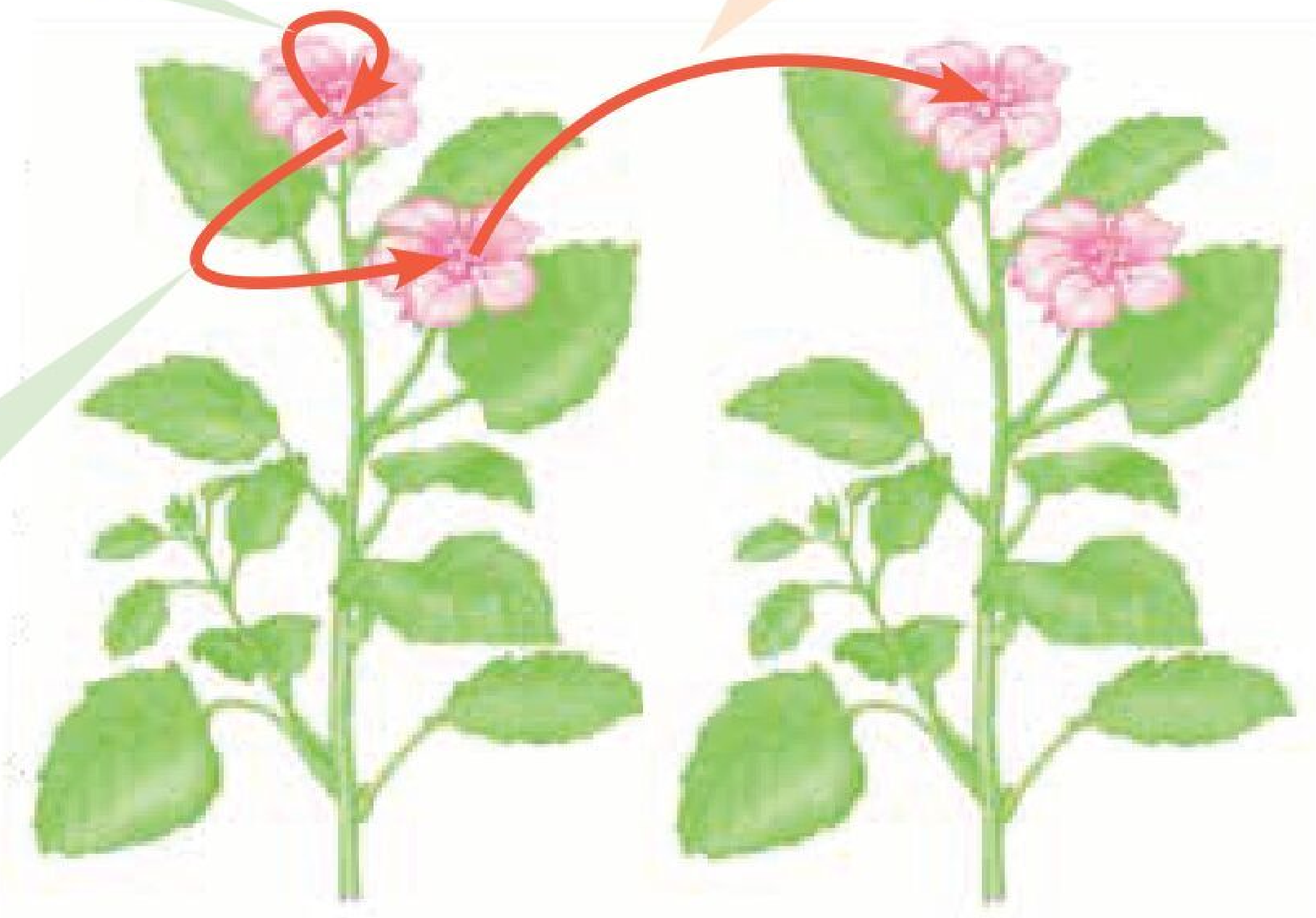
Pollination

Self pollination

It is the process where pollen grains are transferred from the anther of a flower to the stigma of either the same or genetically similar flower.

Geitonogamy

Transfer of pollen grains from anther of one flower to stigma of another flower present in the same inflorescence or in the same plant.



Major types of pollination (According to agents)

- **Wind pollination :** Grasses
- **Water pollination :** *Vallisneria, Hydrilla, Zostera,* Sea grasses.
- **Aquatic Plants (Water hyacinth and water lily) :** Pollinate *via* wind or insects.

Devices to prevent self pollination

Production of unisexual flowers	Castor, maize	Prevent autogamy but not geitonogamy
Production of dioecious plants	Papaya	Prevents both autogamy and geitonogamy

Ploidy

Nucellus	2n	Megaspore mother cell	2n
Functional megaspore	n	Female gametophyte	n
Zygote	2n	Coleoptile	2n
Pericarp	2n	Plumule	2n
Endosperm	3n	Radicle	2n
Scutellum	2n	Coleorhiza	2n

Seeds

Non-albuminous seeds	No residual endosperm. *e.g.,* pea, groundnut
Albuminous seeds	Retain endosperm. *e.g.,* wheat, maize, barley, castor
Persistent nucellus	Black pepper, beet

03 | Human Reproduction

Male Reproductive System

- Primary sex organs : Testis (Present in Scrotum)
- Male Accessory Ducts : Rete testis, Vasa efferentia, epididymis and vas deferens.
- External genitalia – Penis
- Accessory glands – Paired seminal vesicles, a prostate and paired bulbourethral glands.

- The correct sequence for transport of sperm cells in male reproductive system is as follows:

Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens → Ejaculatory duct → Urethra → Urethral meatus

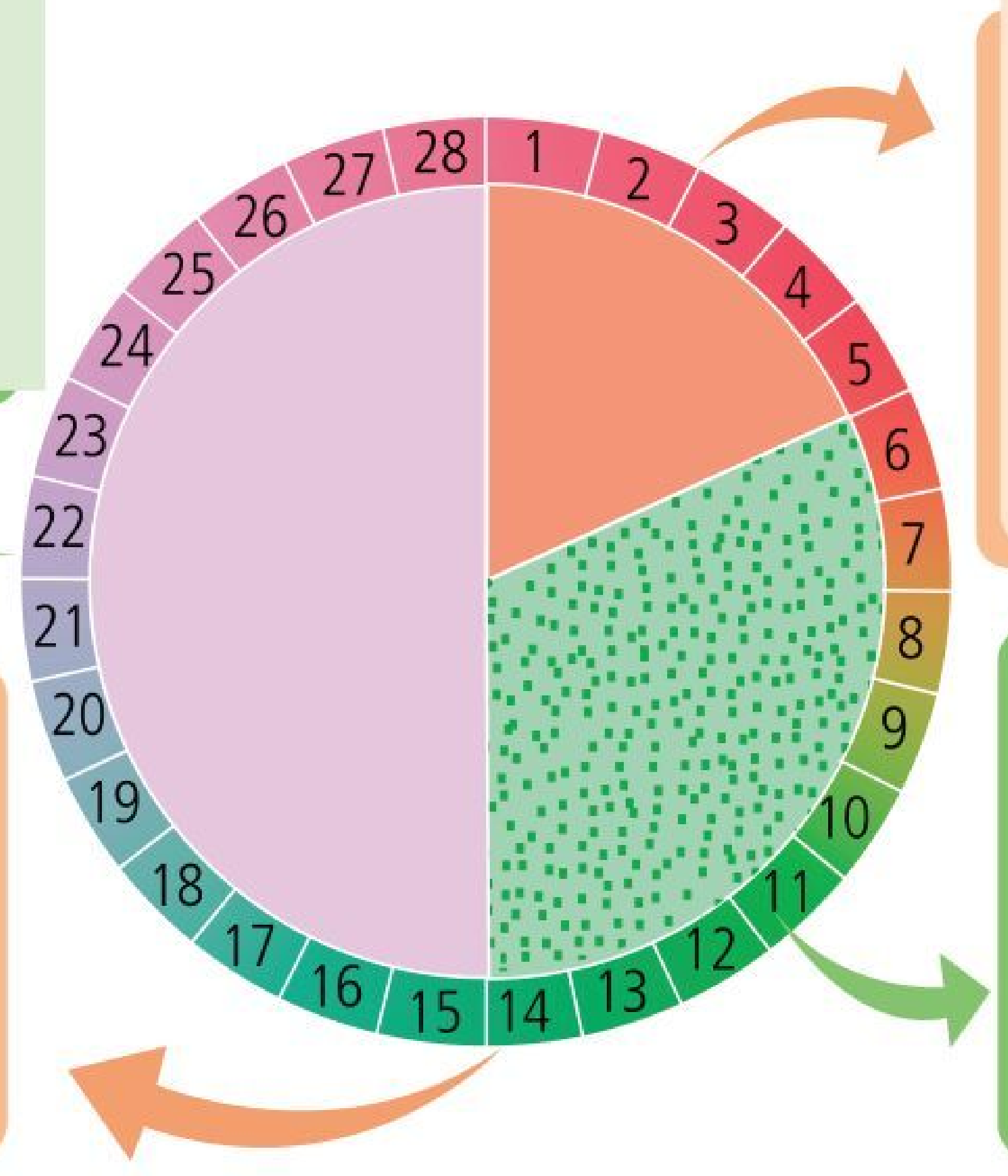
Spermatogenesis

Spermatogonium (2n) $\xrightarrow{\text{Mitosis}}$ 1°spermatocyte (2n) $\xrightarrow{\text{Meiosis}}$

2°spermatocyte (n) $\xrightarrow{\text{Meiosis II}}$ Spermatid (n) → Spermatozoa (n)

- The **scrotum** maintains the temperature of testes 2-2.5°C lower than the normal internal body temperature (37°C) as it could hamper the development of sperms.
- Leydig cells synthesise **androgens**.
- Testis perform two functions, *i.e.*, production of sperms and secretion of male sex hormone.

Menstrual Cycle



Luteal phase (secretory phase)
Corpus luteum secretes progesterone

Menstrual phase
Endometrium breaks down. Progesterone production is reduced

Follicular phase (proliferative phase)
LH, FSH and Estrogen increases

Ovulatory phase
(LH and FSH attain a peak level)

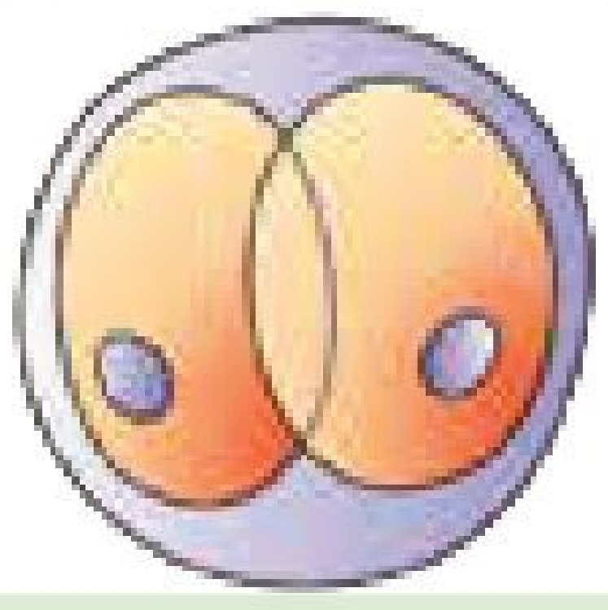
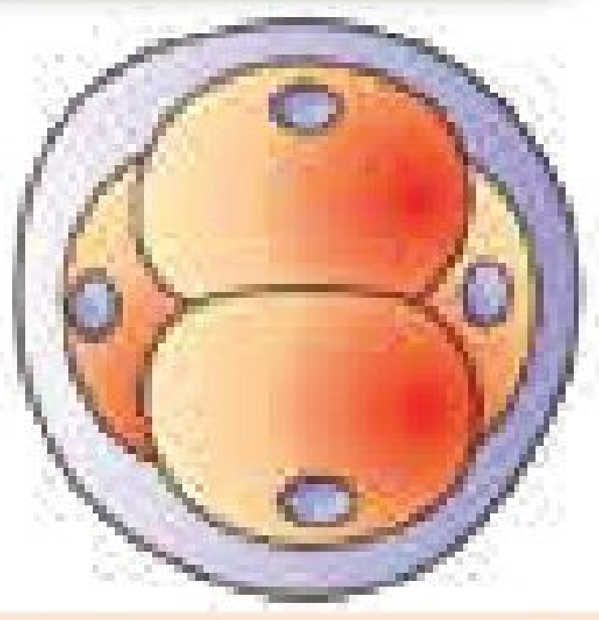
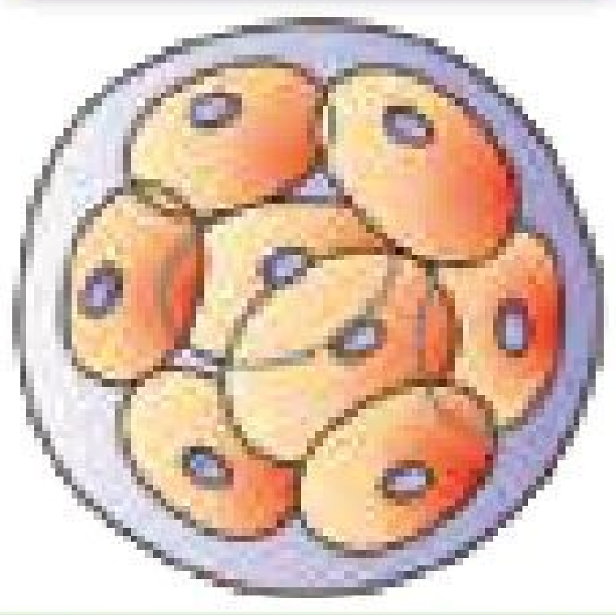
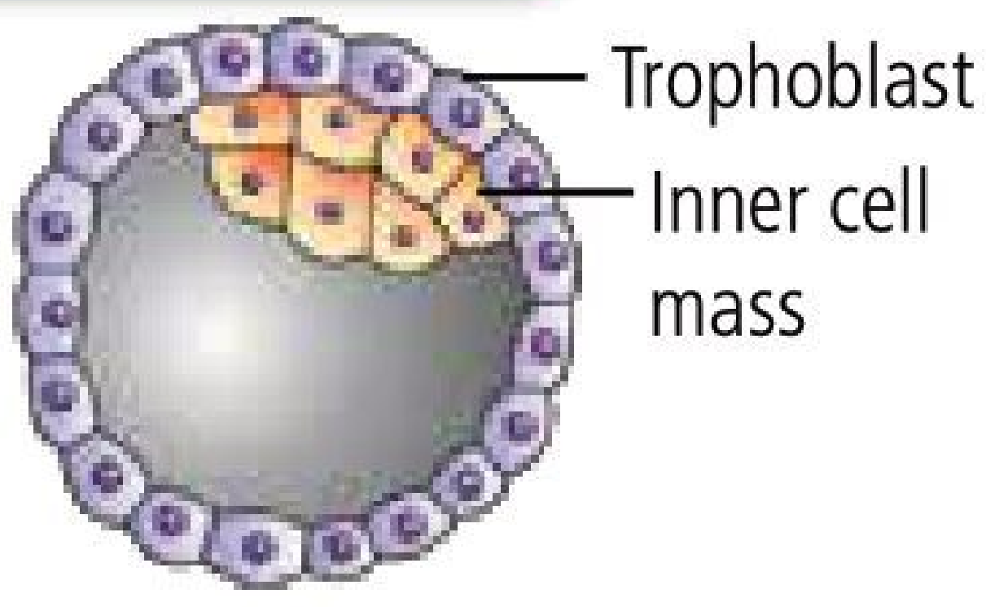
Female Reproductive System

- Primary sex organs : Ovaries
- Female accessory ducts : Oviducts (Fallopian tubes), uterus and vagina.
- Female external genitalia : Mons pubis, labia, majora, labia minora, hymen and clitoris.

Oogenesis

Oogonia (46) → Primary oocyte (46) → Secondary oocyte (23) → Ovum (23)

Fertilisation and Implantation

Zygote	Cleavage	Morula	Blastocyst
			
Haploid sperm unites with haploid egg	Mitotic divisions start forming blastomeres (2, 4, 8, 16 cells)	Solid ball of 8-16 blastomeres formed	Implantation occurs, embryonic disc forms, primary germ layers established

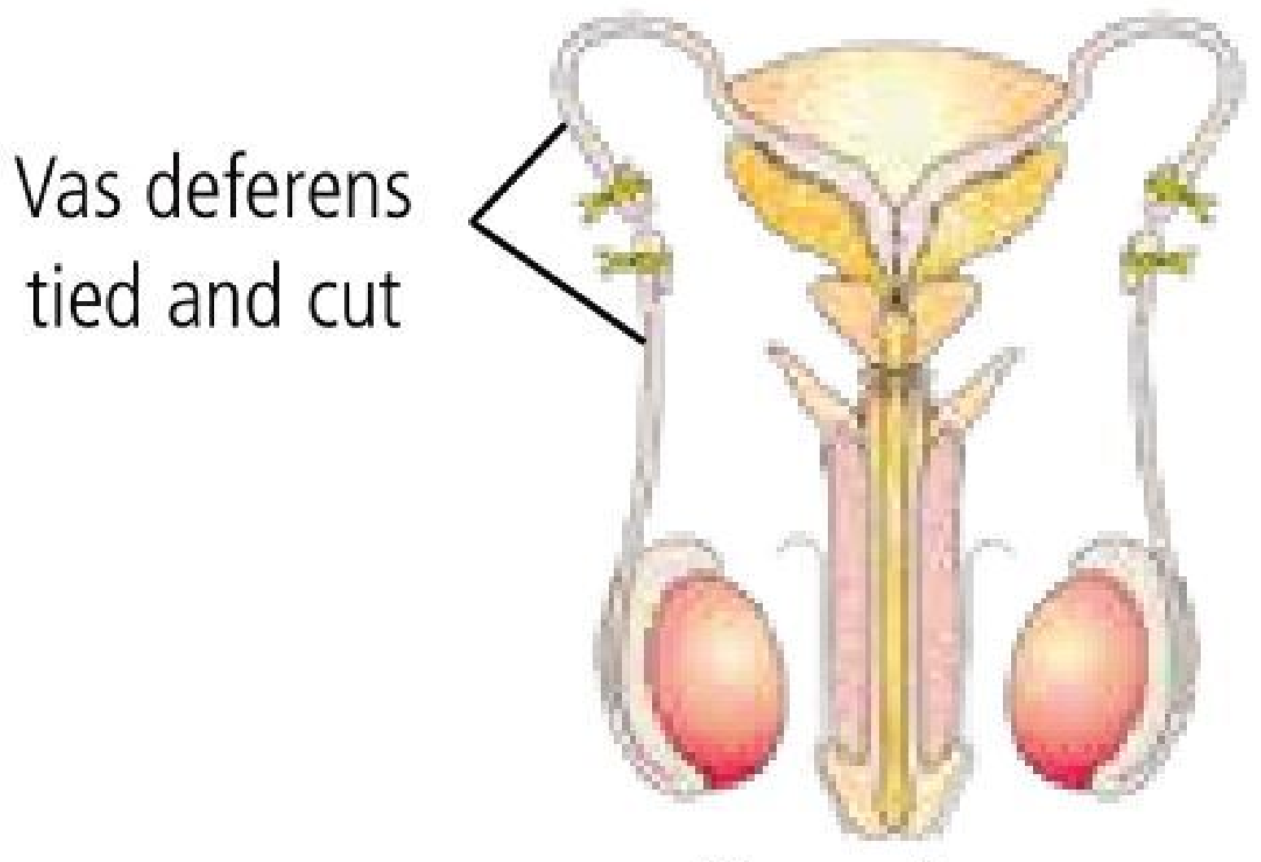
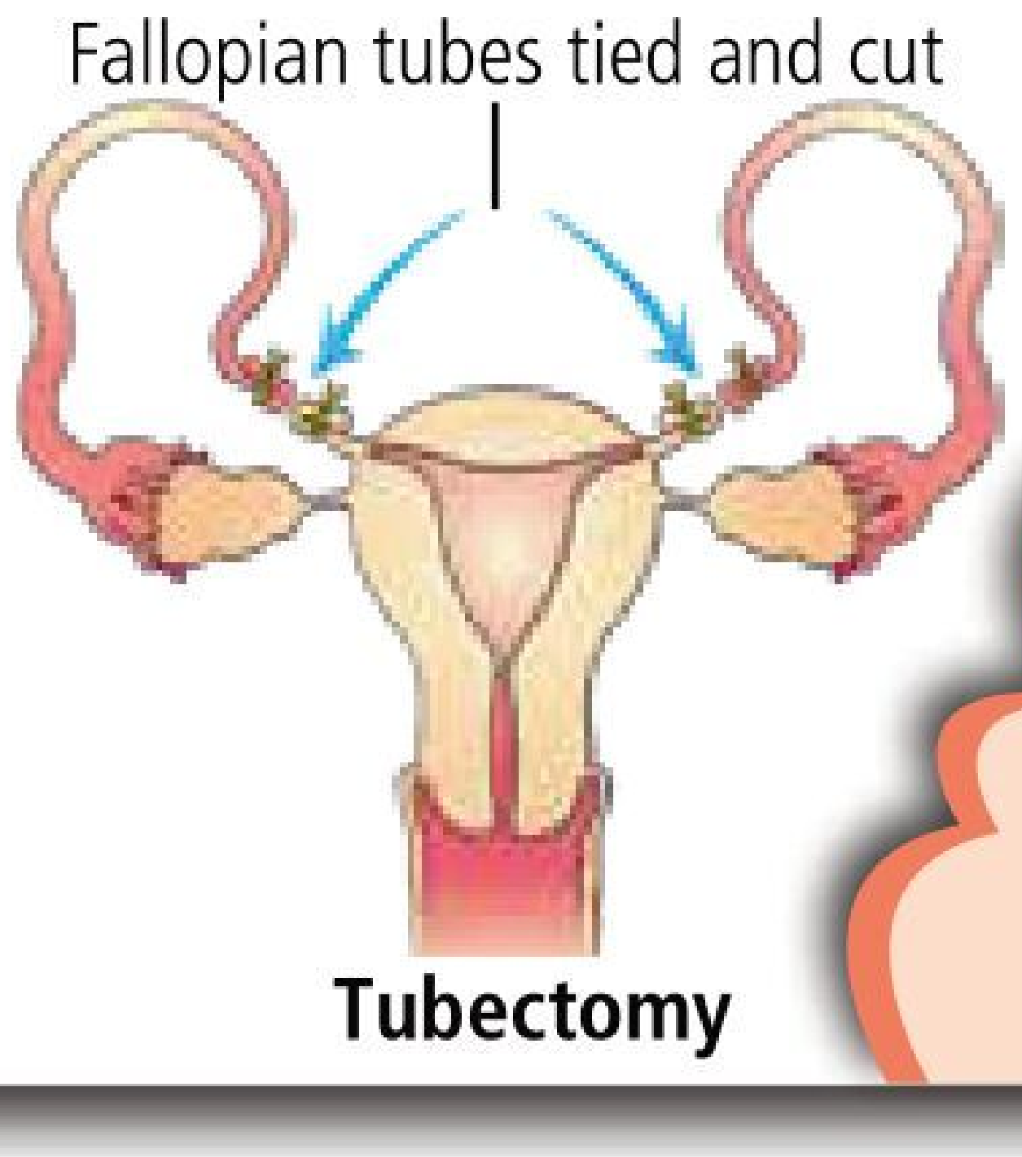
Placenta (Dual function)	(i) Supply of O_2 nutrients to embryo. (ii) Release of hormones : human chronionic gonadotropin (hCG), human placental lactogen (hPL), estrogen, progesterone, etc.

Features of embryonic development at various months of pregnancy

Week 4	Week 8	Week 12	Week 20	Week 24
Formation of heart	Fetus develops digits and limbs	Limbs and external genital organs develop	Movement of fetus, appearance of hair	Body covered by fine hair, eyelids separate, eyes lashes form

04 | Reproductive Health

Contraceptive Methods

Natural methods	It works on the principle of avoiding chances of ovum and sperm meeting : (i) Periodic abstinence; (ii) Coitus interruptus or Withdrawal method; (iii) Lactational amenorrhea method
Barrier methods	Ovum and sperms are prevented from physically meeting with the help of some barriers. *E.g.*, Condoms, Diaphragms, cervical caps and vaults.
Chemical methods	Spermicidal creams, jellies and foams are usually used along with the barriers to increase their contraceptive efficiency.
Intrauterine Devices (IUDs)	Increase phagocytosis of sperms within uterus : (i) Non-medicated IUDs : ***e.g.***, (Lippes loop); (ii) Hormone releasing IUDs : ***e.g.***, LNG-20, progestasert; (iii) Copper releasing IUDs : ***e.g.***, CuT, Cu7, Multiload 375.
Oral contraceptive pills	Estrogen-progestogen or progestogen alone. Inhibit ovulation and implantation. *e.g.*, Saheli, (non-steroidal preparation/**once-a week pill**).
Surgical methods	Sterilisation procedure in the male is called vasectomy and that in the female is called tubectomy. It blocks gamete transport.  Vasectomy  Tubectomy

STDs (Sexually Transmitted Diseases)

Some common STDs are : Gonorrhoea, syphilis, chlamydiasis, genital warts, trichomoniasis.

Hepatitis-B, HIV and genital herpes are incurable STDs.

ART (Assisted Reproductive Technology)

Types of ART are as follows :

Test tube baby

ZIFT

Zygote or early embryo upto 8 blastomeres is transferred into the fallopian tube

IUT

Embryo with more than 8 blastomeres is transferred into the uterus.

Artificial insemination

It is used when the husband is either unable to inseminate the female or has very low sperm counts in the ejaculation.

ICSI

Sperm is directly injected into the cytoplasm of ovum to form an embryo in the laboratory.

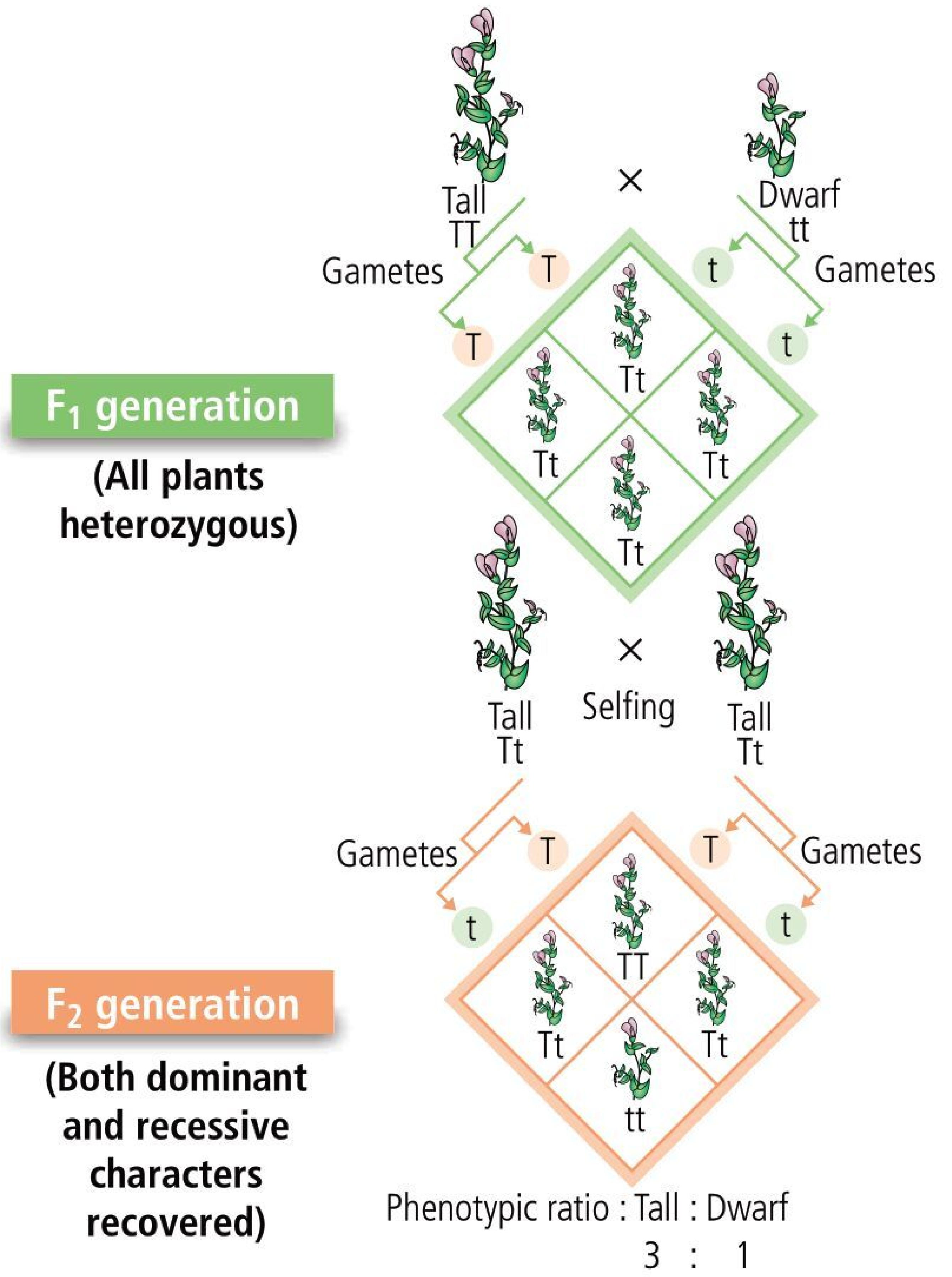
GIFT

Used in females who cannot produce ova but can provide suitable environment for fertilisation.

05 | Principles of Inheritance and Variation

Law of Segregation

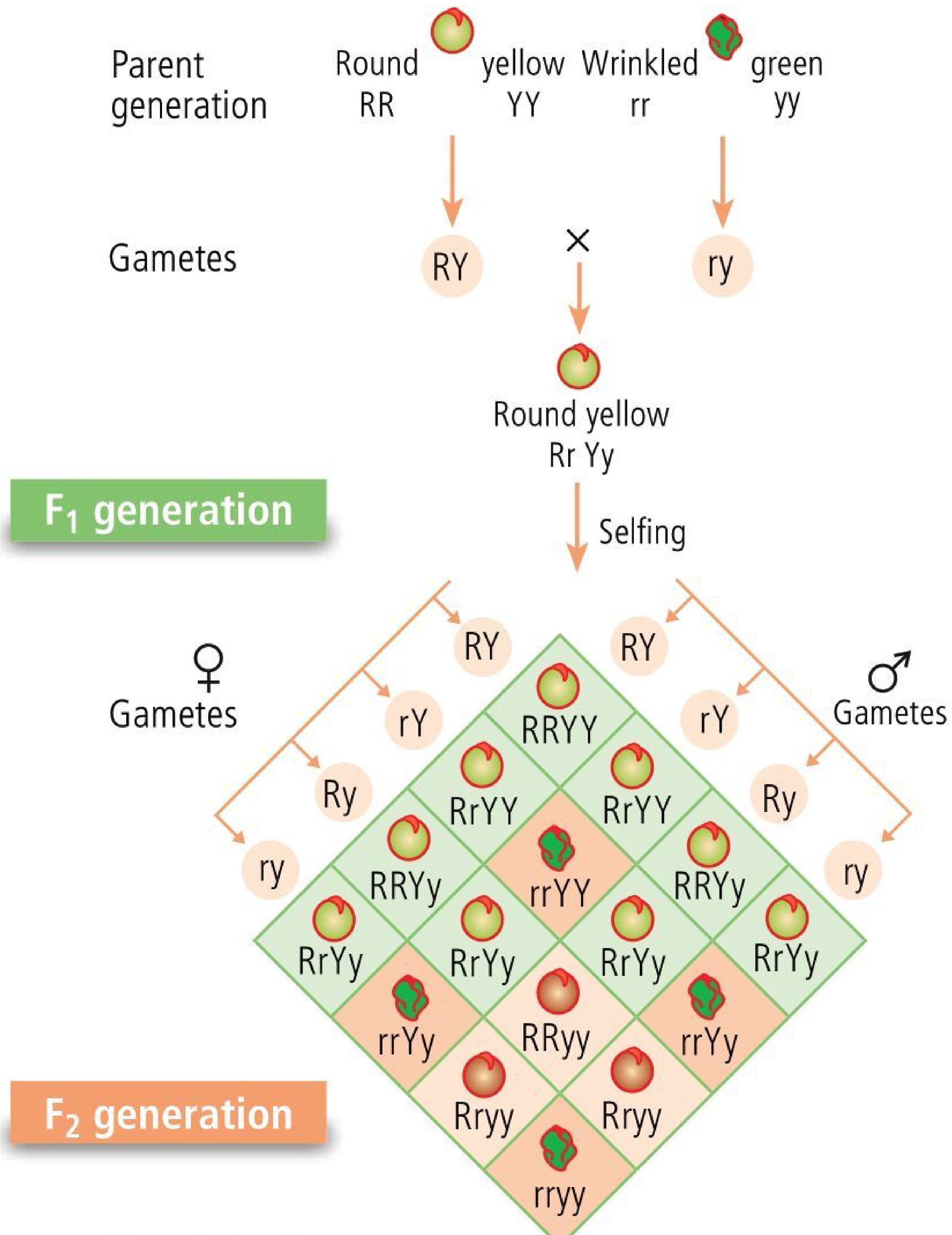
According to the law, alleles do not show any blending and both the characters are recovered as such in the F_2 generation though one of these is not visible in F_1 generation.


Tall
TT
×
Dwarf
tt
Gametes
T
T
t
t
Gametes
Tt
Tt
Tt
Tt
F1 generation
(All plants heterozygous)
Tall
Tt
×
Selfing
Tall
Tt
Gametes
T
t
T
t
Gametes
TT
Tt
Tt
tt
F2 generation
(Both dominant and recessive characters recovered)

Phenotypic ratio : Tall : Dwarf
3 : 1
Genotypic ratio : TT : Tt : tt
1 : 2 : 1

Law of Independent Assortment

When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters.


Parent generation
Round
RR
yellow
YY
Wrinkled
rr
green
yy
Gametes
RY
×
ry
Round yellow
Rr Yy
F1 generation
Selfing
♀
Gametes
RY
rY
Ry
ry
RY
rY
Ry
ry
♂
Gametes
RRYY
RrYY
RrYY
RRYy
rrYY
RRYy
RrYy
RrYy
RrYy
RrYy
rrYy
RRyy
rrYy
Rryy
Rryy
rryy
F2 generation

Phenotypic ratio :

Round yellow	Round green	Wrinkled yellow	Wrinkled green
9	3	3	1

Simple mathematical rules useful in solving genetics problems

- Number of heterozygous gene pairs = n
- Number of different types of gametes formed = 2^n
- Number of different genotypes produced = 3^n
- Number of different phenotypes produced = 2^n

Incomplete dominance

- One of the two alleles of a gene is dominant over each other. *E.g.,* Snapdragon
- F_2 ratio is 1 (RR) Red: 2 (Rr)Pink: 1 (rr) White.

Codominance dominance

- Both the alleles of a gene express simultaneously, *e.g.,* ABO blood grouping.

Polygenic inheritance

Inheritance controlled by three or more genes is called polygenic inheritance. Example : Skin colour and height in humans.

Pleiotropy A single gene influences more than one trait. Example : **phenylketonuria**.

Sex determination

- **ZW-ZZ type** Humans and *Drosophila*
- **XX-XO type** Insects (grasshopper, cockroach) and roundworms
- **ZW-ZZ type** Birds and some reptiles
- **Haploid - Diploid Mechanism of Sex Determination** Ants, honeybees, wasps, etc.

Genetic Disorders

Mendelian disorders

- **Autosomal recessive :** Sickle cell anemia, phenylketonuria, thalassemia
- **Autosomal dominant :** Myotonic dystrophy
- **Sex linked recessive :** Haemophilia, colour blindness

Chromosomal disorders

Syndrome	Karyotype	Main clinical features
Down's syndrome	Trisomy 21	Short, broad palm, mental retardation, small round head, partially open mouth with furrowed tongue.
Turner's syndrome	45, XO	Female with retarded sexual development, rudimentary ovaries, webbed neck, cardiovascular abnormality.
Klinefelter's syndrome	47, XXY	Sterile male with small testes, breast development.

06 | Molecular Basis of Inheritance

- **Chargaff rule** → A + G = T + C
- **Francis Crick** proposed the **central dogma** model

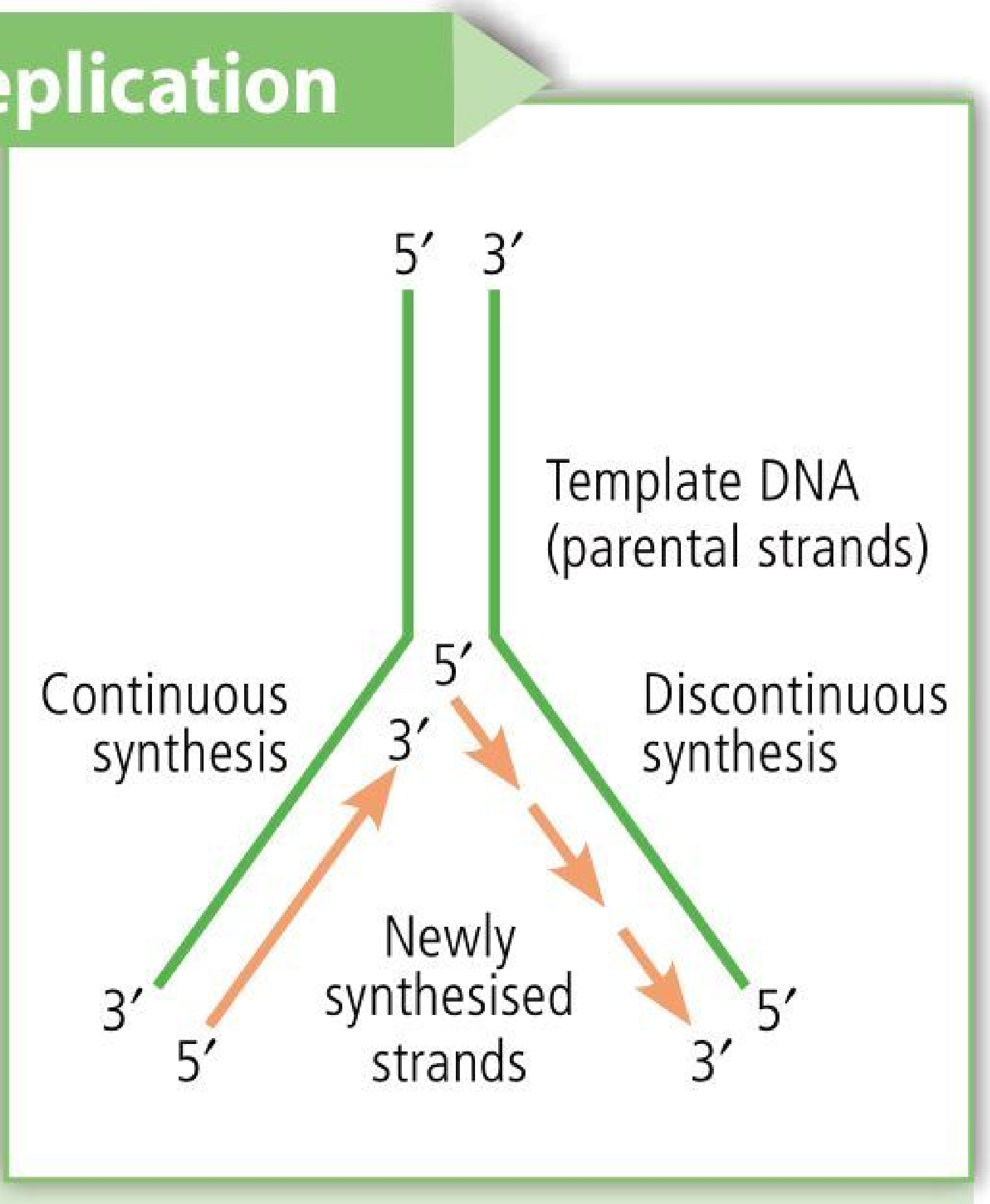
$$\begin{tikzcd}\text{DNA} \arrow[loop above, "\text{Replication}"] \arrow[r, "\text{Transcription}"] & m\text{RNA} \arrow[r, "\text{Translation}"] & \text{Protein}\end{tikzcd}$$

Results of Avery's Experiment

Mixture	Result
R-type bacteria + carbohydrates of S-type bacteria	R-type bacteria
R-type bacteria + protein of S-type bacteria	R-type bacteria
R-type bacteria + DNA of S-type bacteria	S-type + R-type bacteria
R-type bacteria + DNA of S-type bacteria + deoxy-ribonuclease	R-type bacteria

Replication

- **Semi-conservative DNA replication :** Each DNA molecule would have **one parental** and **one newly synthesised** strand after completion of replication. Experimentally proved by **Meselson** and **Stahl**.



- Replication is continuous on template strand with polarity **3′ → 5′** and template with polarity **5′ → 3′** replication is discontinues.

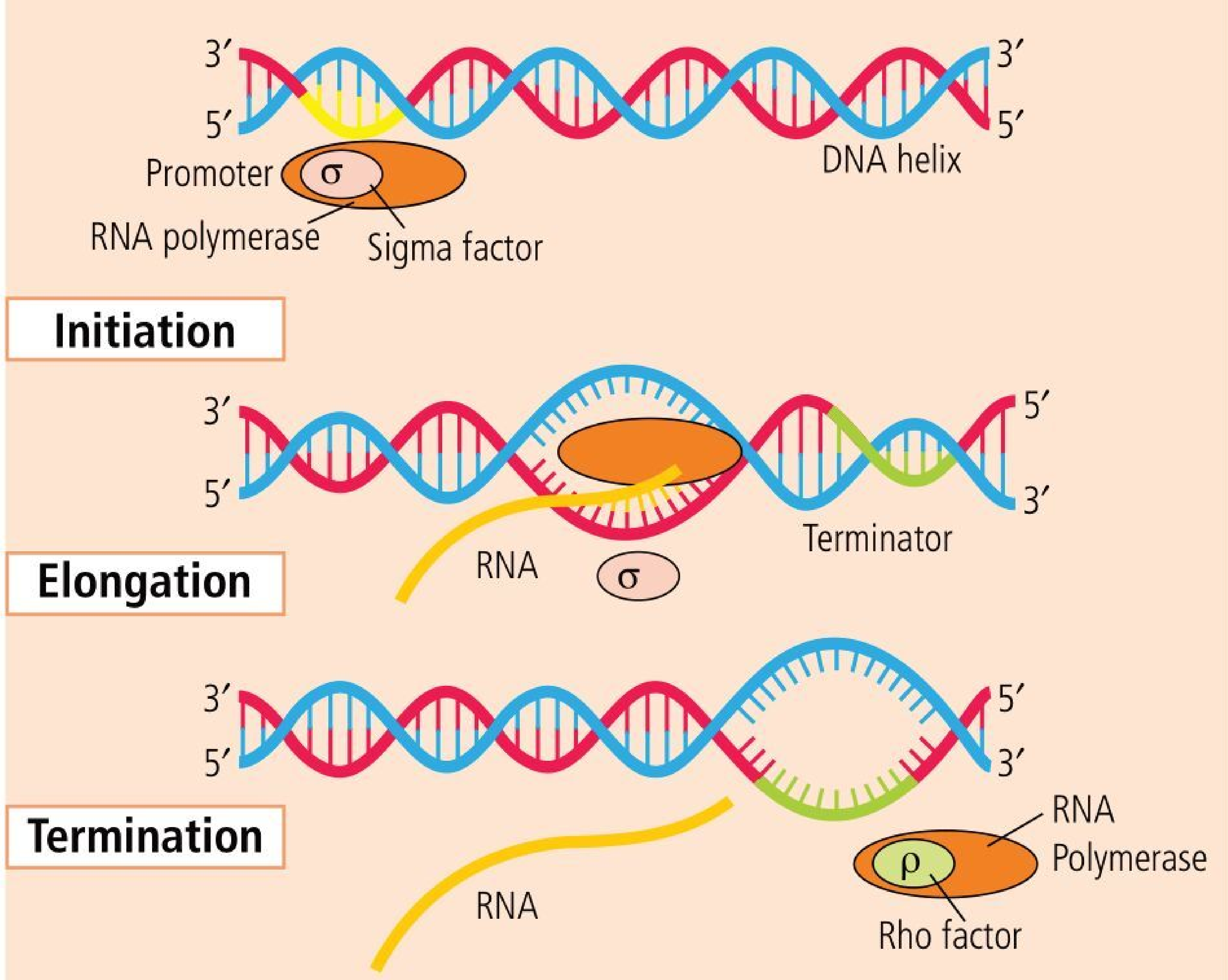
Transcription

- **Main components :** DNA dependent RNA polymerase, DNA ligase, *ori*
- A **transcription unit** in DNA is defined primarily by the three regions in the DNA: (i) A promoter, (ii) The structural gene, (iii) A terminator.

Eukaryotes

- RNA polymerase I – 28S, 18S and 5.8S *r*RNA
- RNA polymerase II – hnRNA
- RNA polymerase III – *t*RNA, 5srRNA, snRNA
- Post transcriptional modifications – Splicing, Capping (5′), Tailing (3′)

mRNA sequence (U in place of T) = Coding strand of DNA


3′
5′
3′
5′
Promoter
σ
DNA helix
RNA polymerase
Sigma factor
Initiation
3′
5′
5′
3′
Elongation
RNA
σ
Terminator
3′
5′
5′
3′
Termination
RNA
ρ
RNA Polymerase
Rho factor

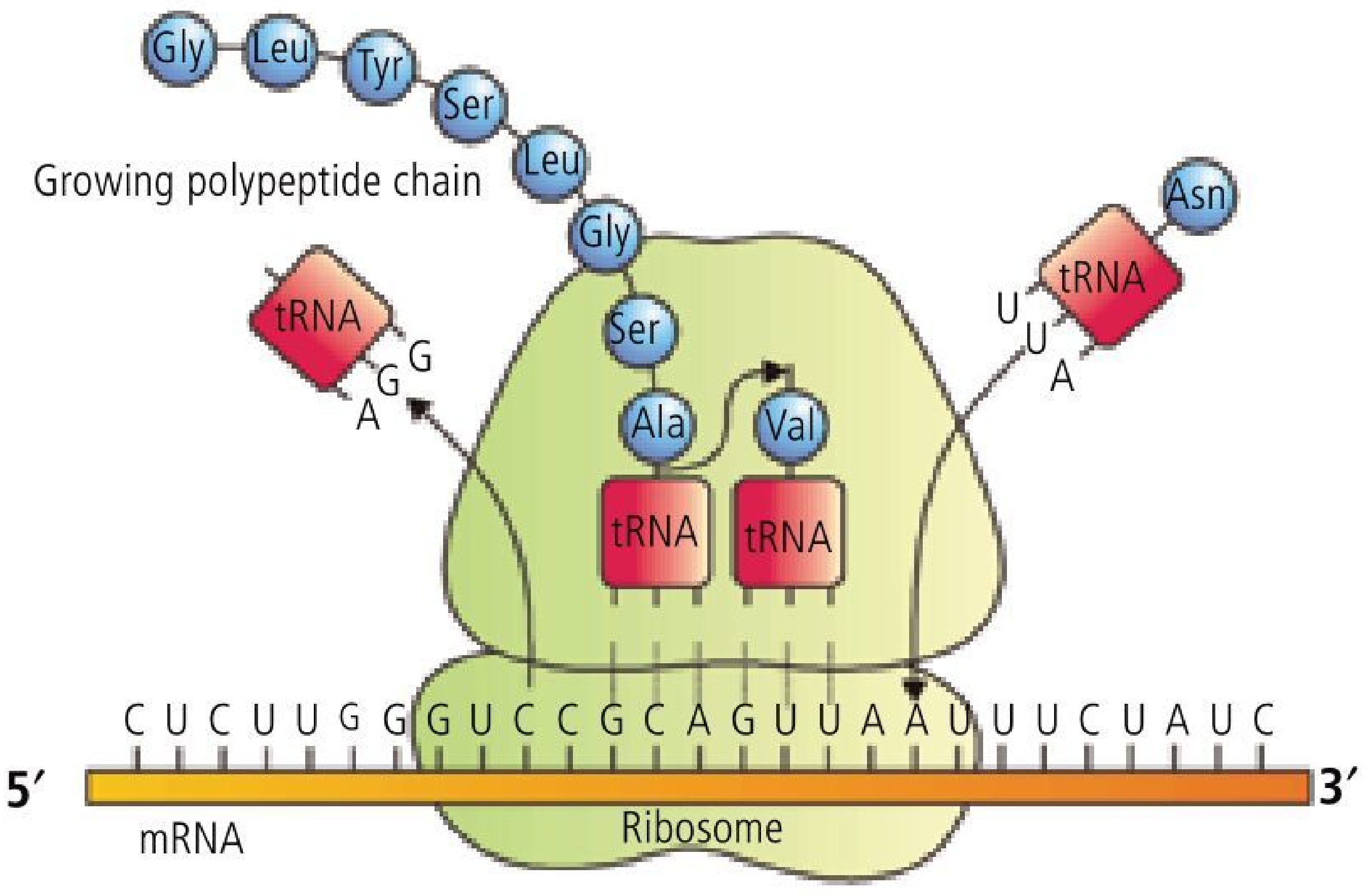
Genetic code

- Universal, degenerate, Non-overlapping
- Initiator codon – Methionine (AUG)
- Terminator codon – UAG, UGA, UAA

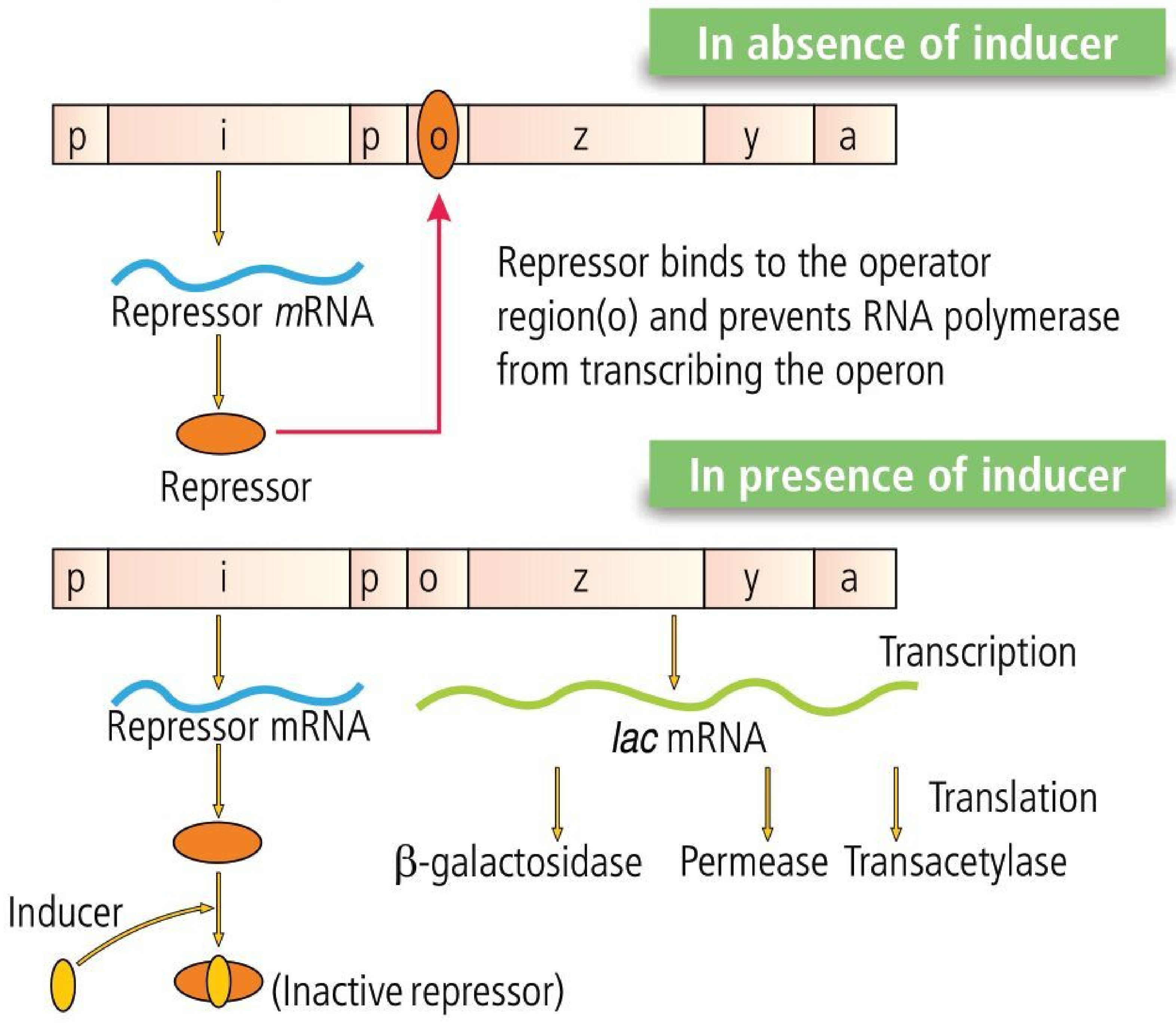
Translation

Sequence of translation is as follows:

- Charging of *t*RNA or aminoacylation of *t*RNA.
- Small subunit of ribosome encounter *m*RNA.
- Ribosome binds to *m*RNA at AUG is recognised by initiator *t*RNA.
- **Elongation phase** - Amino acid-*t*RNA bind to appropriate codon in *m*RNA.
- Amino acids are added one by one, translated into polypeptide sequences.
- Release factor binds to stop codon.
- Release of complete polypeptide from ribosome.


Gly
Leu
Tyr
Ser
Leu
Gly
Ser
Ala
Val
Asn
Growing polypeptide chain
tRNA
G
G
A
tRNA
U
U
A
tRNA
tRNA
C U C U U G G G U C C G C A G U U A A U U U C U A U C
5′
3′
mRNA
Ribosome

Lac operon


In absence of inducer
p
i
p
o
z
y
a
Repressor *m*RNA
Repressor
In presence of inducer
p
i
p
o
z
y
a
Transcription
Repressor mRNA
lac mRNA
Translation
β-galactosidase
Permease
Transacetylase
Inducer
(Inactive repressor)

Repressor binds to the operator region(o) and prevents RNA polymerase from transcribing the operon

07 | Evolution

Origin of Life

Previous conditions on earth - High temperature, volcanic storms, **reducing atmosphere**.

Chemical Evolution

- In 1953, **Miller** passed electric discharge in a closed flask containing CH_4, H_2, NH_3 and water vapour at 800°C and observed formation of amino acids.

Natural selection

- **Industrial melanism :** After industrialisation, barks got covered by smoke, so the **white moths were selectively picked** up by birds.
- But **black moths escaped unnoticed** so they managed to survive resulting in more population of black moths and less population of white moths.

Hardy Weinberg Equilibrium

The relative frequencies of various kinds of genes in a large and randomly mating population tend to remain constant from generation to generation.

Evidences from comparative anatomy and morphology

Homologous organs (Divergent evolution) – Same fundamental pattern, different functions

- Forelimbs of whales, bats, cheetah and humans
- Vertebrate heart or brain
- Tendrils of *Bougainvillea* and *Cucurbita*

Analogous organs (Convergent evolution) – Different structure, same function

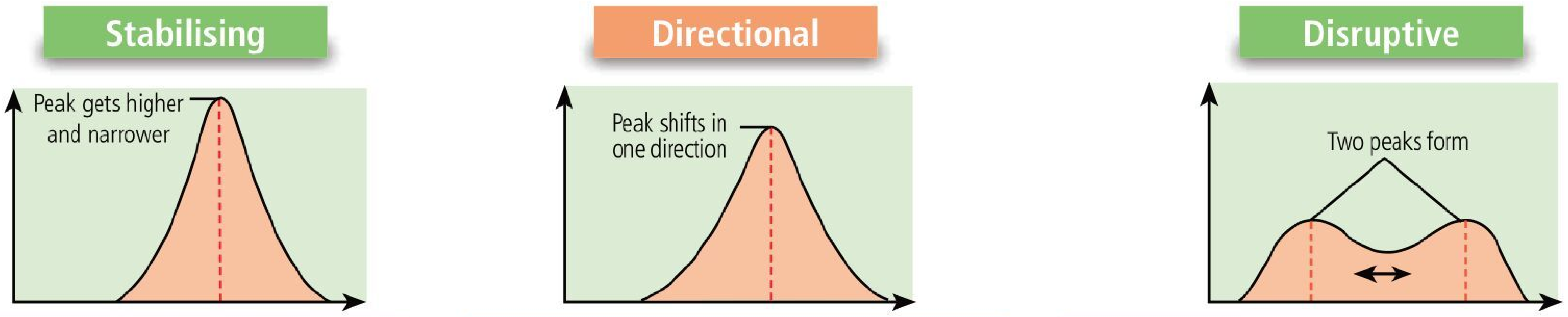
- Wings of butterfly and birds
- Eyes of octopus and mammals
- Flippers of Penguins and Dolphins
- Sweet Potato (Root modification) and potato (stem modification)

Formula

- $p^2 + 2pq + q^2 = 1$
  $p + q = 1$ where,
  p = Frequency of the dominant allele in the population.
- q = Frequency of the recessive allele in the population.
- p^2 = Frequency of homozygous dominant individuals.
- q^2 = Frequency of homozygous recessive individuals.
- $2pq$ = Frequency of heterozygous individuals.

Factors affecting Hardy Weinberg equilibrium

Gene migration or gene flow, genetic drift, mutation, genetic recombination and natural selection.



More individuals acquire mean character value.

More individuals acquire value other than the mean character value

More individuals acquire peripheral character value at both ends of the distribution curve

Diagrammatic representation of operation of natural selection

Evolution of Man

Dryopithecus ➤ *Ramapithecus* ➤ *Australopithecus* ➤ *Homo habilis* ➤ *Homo erectus* ➤ *Neanderthal man* ➤ *Homo sapiens*

.... to be continued

Check Your Vitals for NEET

Maximise your chance of success in medical entrance exams by reading this article. This section is specially designed to optimise your preparation by practising more and more. It is a unitwise series having chapterwise question bank, allowing you to prepare systematically and become more competent.

- Recall question or single concept question – indicated by a single finger.
- Application question or question which requires 2 or 3 concepts - indicated by 2 fingers.
- Application question or question which requires 3 or more concepts - indicated by 3 fingers.

UNIT-V : HUMAN PHYSIOLOGY - I

CHAPTER-16 : DIGESTION AND ABSORPTION

Multiple Choice Questions

1. Which one of the following is the correct matching of the site of action, the substrate, the enzyme acting upon it and the end product?

(a) Small intestine : proteins $\xrightarrow{\text{Pepsin}}$ amino acids
(b) Stomach : fats $\xrightarrow{\text{Lipase}}$ micelles
(c) Duodenum : triglycerides $\xrightarrow{\text{Trypsin}}$ monoglycerides
(d) Small intestine : starch $\xrightarrow{\text{Amylase}}$ disaccharides

2. Which one of the following pairs is correctly matched?

(a) Oxyntic cells - a secretion with pH between 2.0 and 3.0
(b) Alpha cells of islets of Langerhans - a secretion that decreases blood sugar level
(c) Kupffer cells - a digestive enzyme that hydrolyses nucleic acids
(d) Chief cells - a secretion that is rich in mucin.

3. If we take food rich in lime juice, then

(a) action of ptyalin on starch is enhanced
(b) action of ptyalin on starch is reduced
(c) action of ptyalin on starch is unaffected
(d) action of ptyalin on starch stops.

4. In which of the following order, the process of nutrition proceeds?

(a) Ingestion → Assimilation → Absorption → Accumulation Egestion
(b) Digestion → Ingestion → Assimilation → Absorption → Egestion
(c) Ingestion → Digestion → Assimilation → Absorption → Egestion
(d) Ingestion → Digestion → Absorption → Assimilation → Egestion

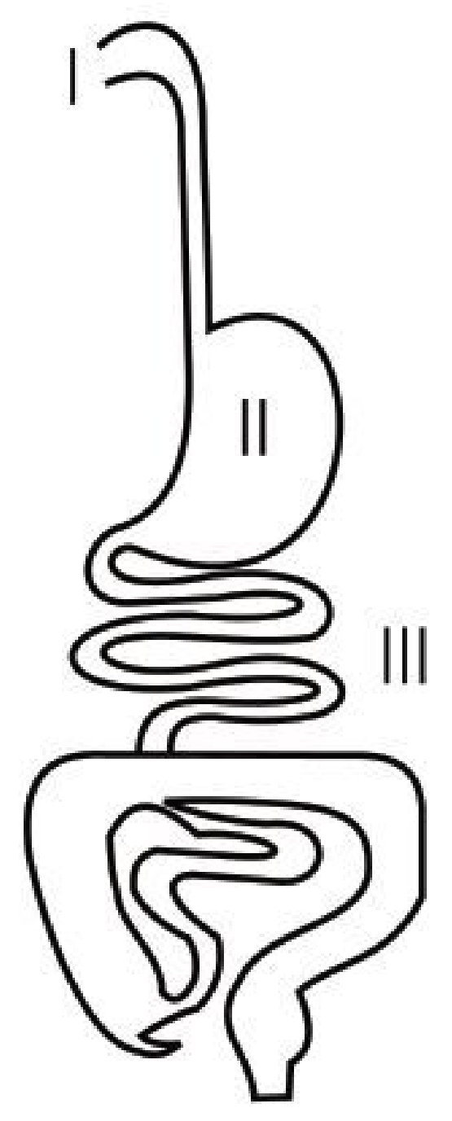
5. Which sphincter guards the opening between the oesophagus and stomach?

(a) Gastroesophageal sphincter
(b) Pyloric sphincter
(c) Sphincter of Oddi
(d) Cardiac sphincter

6. Which enzymes are likely to act on the baked potatoes eaten by a man, starting from the mouth and as it moves down the alimentary canal?

(a) Pancreatic amylase → salivary amylase → lipases
(b) Maltase → lipases → nucleases
(c) Salivary amylase → pancreatic amylase → disaccharidases
(d) Salivary maltase → carboxy-peptidase → trypsinogen

7. During the process of digestion, food is exposed to a range of pH. The relative pH of fluids in I, II and III regions of the alimentary canal shown in this diagram is



(a) I > II < III
(b) I > II > III
(c) I < II < III
(d) I < II > III

8. Which of the following are proteolytic enzymes?

(a) Ptyalin, trypsin, pepsin
(b) Lipase, erepsin, trypsin

(c) Erepsin, trypsin, pepsin
(d) Pepsin, nuclease, nucleotidase

9. In the gastrointestinal tract, the Meissner's plexus and the Auerbach's plexus occur respectively in the
(a) lamina propria and muscularis mucosa
(b) submucosa and muscularis externa
(c) submucosa and mucosa
(d) mucosa and muscularis externa.

10. Which of the following is the function of enterogastrone?
(a) It inhibits the secretion of gastric juice.
(b) It stimulates the secretion of digestive juices in the stomach.
(c) It stimulates the flow of pancreatic juice.
(d) It regulates the flow of bile.

11. Which of the following statements is correct?
(a) Argentaffin cells produce serotonin
(b) Villikinin is secreted by large intestine
(c) Brunner's glands are found in jejunum
(d) Succus entericus has pH of 2.8

12. If for some reason our goblet cells are non-functional, then which of the following will be adversely affected?
(a) Production of somatostatin
(b) Production of secretin
(c) Secretion of duocrinin
(d) Protection of intestinal mucosa

13. $\text{Milk casein} \xrightarrow{\mathbf{Y}} \text{Paracasein} + \mathbf{M} \longrightarrow \text{Calcium paracaseinate}$ (Curdling of milk)

In the above question letters 'Y' and 'M' denote
(a) rennin and Ca^{++} respectively
(b) Ca^{++} and rennin respectively
(c) rennin and HCl respectively
(d) HCl and Ca^{++} respectively.

14. Which of the following statements are correct regarding secretion of oxyntic cells?
(i) It denatures proteins and softens fibrous connective tissues in the blood.
(ii) It activates rennin.
(iii) It renders calcium and iron salts suitable for absorption in the intestine.
(iv) It activates trypsin.
(a) (i) and (iv)
(b) (ii), (iii) and (iv)
(c) (i), (ii) and (iii)
(d) (i), (iii) and (iv)

15. Which of the following statements is correct?
(a) The sight and smell of food while having your meal, enhances efficiency of digestion.
(b) One should always have food till his/her stomach is completely full. This enhances digestion.
(c) Drinking water while having meal enhances stretching effect on the stomach wall, hence enhances digestion.
(d) None of these.

Match The Columns

16. Match the column I with column II.

Column I	Column II
A. Goblet cells	(i) Antibacterial agent
B. Lysozyme	(ii) Mucus
C. Saliva	(iii) Pepsinogen
D. Chief cells	(iv) Sublingual gland

17. Match the column I with column II. (There can be more than one match for items in column I.)

Column I	Column II
A. Bile salts	(i) Fatty acids and glycerol
B. *Escherichia coli*	(ii) Hepatocytes
C. Duocrinin	(iii) Xerophthalmia
D. Vitamin A	(iv) Emulsification
E. Steapsin	(v) Colon
	(vi) Cobalamin
	(vii) Antioxidant
	(viii) Brunner's gland
	(ix) Pancreas
	(x) Gastrointestinal hormone

Passage Based Questions

18.(A) Complete the given passage with appropriate words.

Digestive glands play a crucial role in secretion of various enzymes and hormones. The duct of parotid glands in mouth, is called (i) duct. A viral infection of these glands is called (ii). (iii) cells of gastric glands secrete hydrochloric acid and Castle's intrinsic factor. pH of infant's gastric juice is (iv). (v) cells of liver are phagocytic as they eat up old and damaged WBCs, RBCs and bacteria. (vi) is an anticoagulant secreted by liver. Bile contains no enzyme, but it breaks the larger fat droplets into smaller one. This process is called (vii). Alpha cells of pancreas produce a hormone called (viii). (ix) cells are found in the bottom of crypts of Lieberkuhn.

(B) Read the given passage and correct the errors, wherever present.

The exocrine part of pancreas consists of groups of islets of Langerhans. They are most numerous in the head of the pancreas. Each islet of Langerhans consists of alpha cells (α-cells), beta cells (β-cells) and delta cells (δ cells). Alpha cells produce insulin hormone which converts glycogen into glucose in the stomach. Beta cells produce glucagon hormone which converts glucose into glycogen in the duodenum and jejunum. Delta cells secrete secretin hormone which stimulates the secretion of glucagon and insulin.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
(a) If both A and R are true and R is the correct explanation of A

(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. **Assertion :** Many babies experience neonatal jaundice.
Reason : Neonatal jaundice is caused due to poor functioning of liver for a week after birth.

20. **Assertion :** Fatty acids are converted to chylomicrons and transferred into lymph capillaries called lacteals.
Reason : Fatty acids being insoluble in water cannot be directly absorbed into blood.

21. **Assertion :** Hydrochloric acid cannot digest the stomach wall.
Reason : Hydrochloric acid can denature the enzymes.

22. **Assertion :** Protein digestion starts in the stomach, not in the buccal cavity.
Reason : An absence of acidic environment in buccal cavity fails to activate proteases and peptidases.

23. **Assertion :** *E.coli* inhabits the colon but is not killed by body defense system.
Reason : *E.coli* produces cobalamin, thiamine and riboflavin.

24. **Assertion :** Peristalsis is the pushing of food through the oesophagus by muscular movement.
Reason : Persistaltic movement helps in breaking down of food particles into simpler substances.

25. **Assertion :** Pepsin activation is an autocatalytic reaction.
Reason : Activated pepsin itself changes pepsinogen into pepsin.

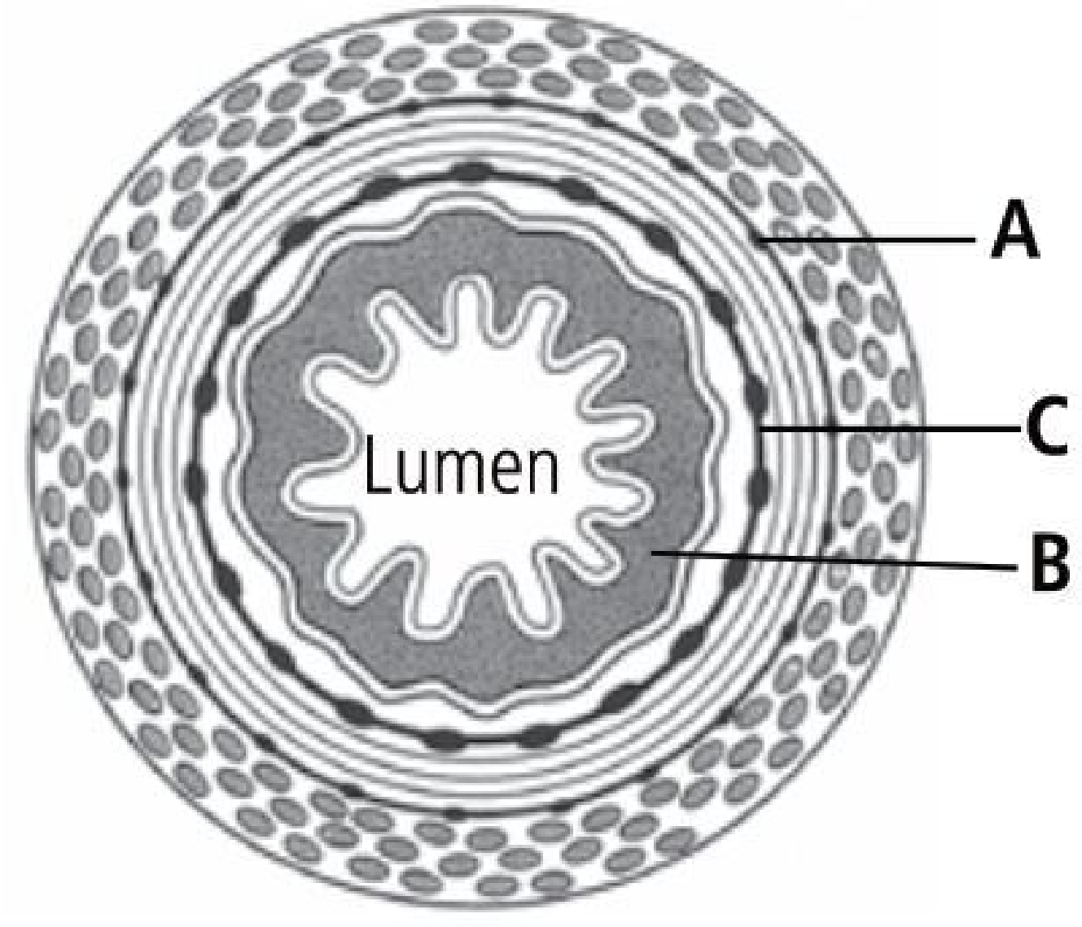
26. **Assertion :** Marasmus affects children below age of one year and the symptoms include prominent ribs, wrinkled skin and thin limbs.
Reason : Deficiency of both proteins and calories in diet causes marasmus.

27. **Assertion :** Neural control of digestion is regulated by vagus nerve.
Reason : Vagus nerve stimulation increases secretion of pancreatic juice.

28. **Assertion :** Infants are not able to control defecation.
Reason : In infants, defecation occurs by reflex action without the voluntary control of anal sphincter.

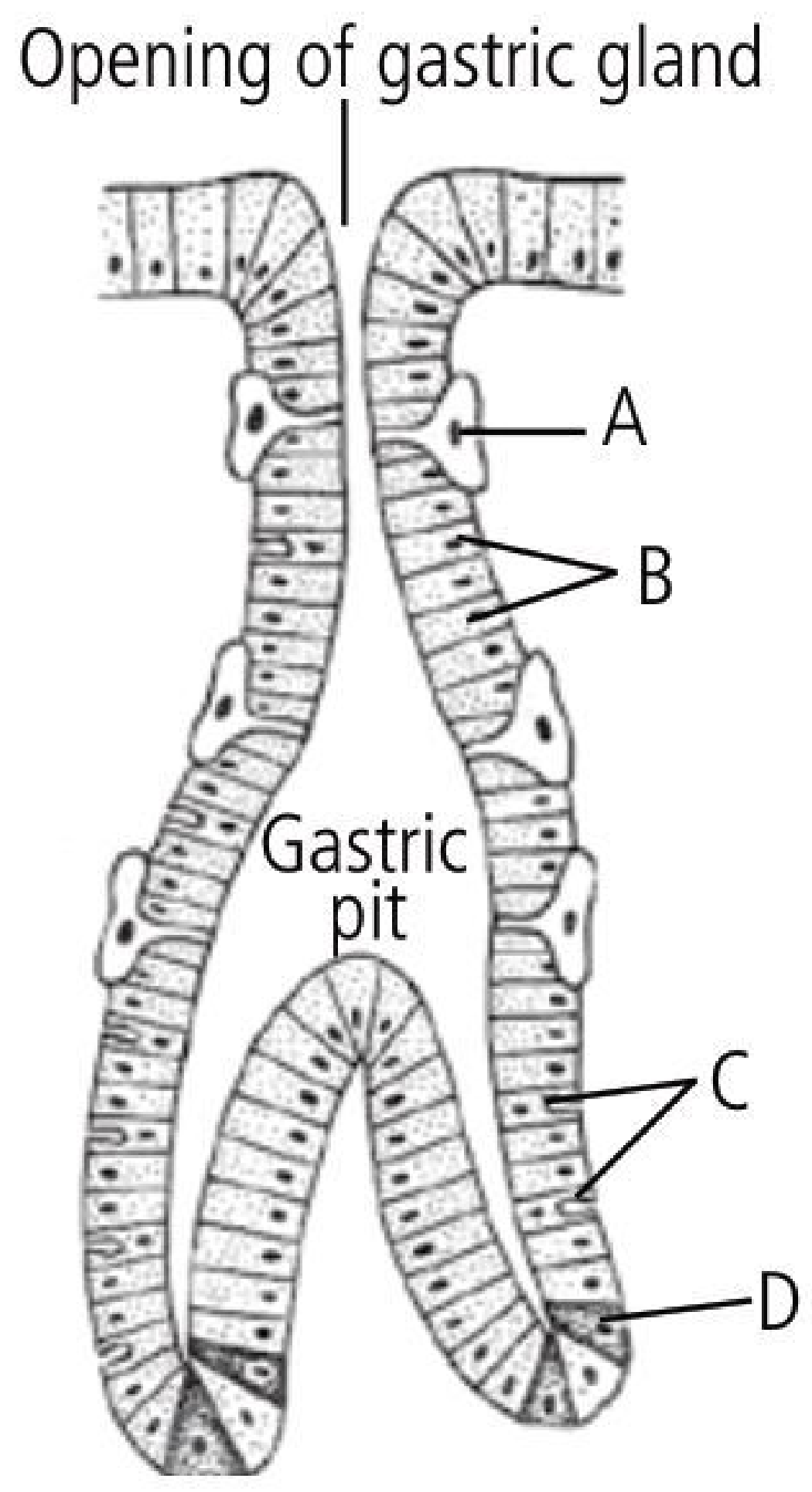
Figure Based Questions

29. Study the given diagrammatic representation of transverse section of gut and answer the following questions.



(a) Identify the label A. What is its function?
(b) Layer B is a mucosal layer and consists of blood vessels, connective tissue and lymphoid tissues. Identify B.
(c) What does 'C' represent? In which layer is 'C' present?

30. Refer to the given figure and answer the following questions.



(a) Identify A, B, C, and D in the given figure.
(b) What will happen if A and B type of cells are removed from the stomach epithelium?

CHAPTER-17 : BREATHING AND EXCHANGE OF GASES

Multiple Choice Questions

1. About 1000 mL of air is always known to remain inside the human lungs. It is described as _________.
(a) inspiratory reserve volume
(b) expiratory reserve volume
(c) residual volume (d) tidal volume

2. Inspiration occurs when there is a negative pressure in the lungs with respect to atmospheric pressure. This negative pressure is achieved when
(a) intrapulmonary pressure is less than the atmospheric pressure
(b) intrapulmonary pressure is greater than the atmospheric pressure
(c) intrapulmonary pressure is equal to the atmospheric pressure
(d) intrapleural pressure becomes more than the intra-alveolar pressure.

3. Between breaths the intrapleural pressure is approximately _____ mm Hg less than atmospheric pressure.
(a) 1 (b) 4 (c) 8 (d) 10

4. Haldane effect plays an important role in promoting carbon dioxide transport than the Bohr's effect in promoting oxygen transport because
(a) oxyhaemoglobin is a stronger acid which donates hydrogen ion (H^+) which in turn displace carbon dioxide from blood.
(b) carbaminohaemoglobin is a stronger acid which splits into hydrogen ion (H^+) and bicarbonate (HCO_3^-).
(c) carbon dioxide reacts with water to form carbonic acid that lowers the pH in tissue.

(d) carbon dioxide is less soluble in venous blood than in arterial blood.

5. Select the correct order of the movement of fresh air into the lungs.
(a) Nasal cavity → Pharynx → Larynx → Trachea → Bronchi → Bronchioles → Alveoli
(b) Nasal cavity → Larynx → Pharynx → Trachea → Bronchioles → Bronchi → Alveoli
(c) Nasal cavity → Larynx → Trachea → Pharynx → Bronchioles → Bronchi → Alveoli
(d) Nasal cavity → Larynx → Pharynx → Trachea → Bronchioles → Bronchi → Alveoli

6. Which of the following symptoms is incorrect regarding emphysema?
(a) Alveolar septa collapse
(b) Regular coughing with thick greenish yellow sputum
(c) Surface area of gas exchange decreases
(d) Loss of elasticity in the walls of alveolar sacs

7. The binding of oxygen with haemoglobin tends to displace carbon dioxide from the blood. This phenomenons known as
(a) Bohr effect
(b) Hamburger's phenomenon
(c) oxygen dissociation curve
(d) Haldane effect.

8. Visiting high mountains may cause altitude sickness in men living in plain areas. Prime cause of this is
(a) excess of CO_2 in blood
(b) decreased efficiency of haemoglobin
(c) decreased partial pressure of oxygen
(d) increased proportion of oxygen in air.

9. Identify the correct statement with reference to transport of respiratory gases by blood?
(a) Haemoglobin is necessary for transport of carbon dioxide and carbonic anhydrase for transport of oxygen
(b) Haemoglobin is necessary for transport of oxygen and carbonic anhydrase for transport of carbon dioxide
(c) Only oxygen is transported by blood
(d) Only carbon dioxide is transported by blood

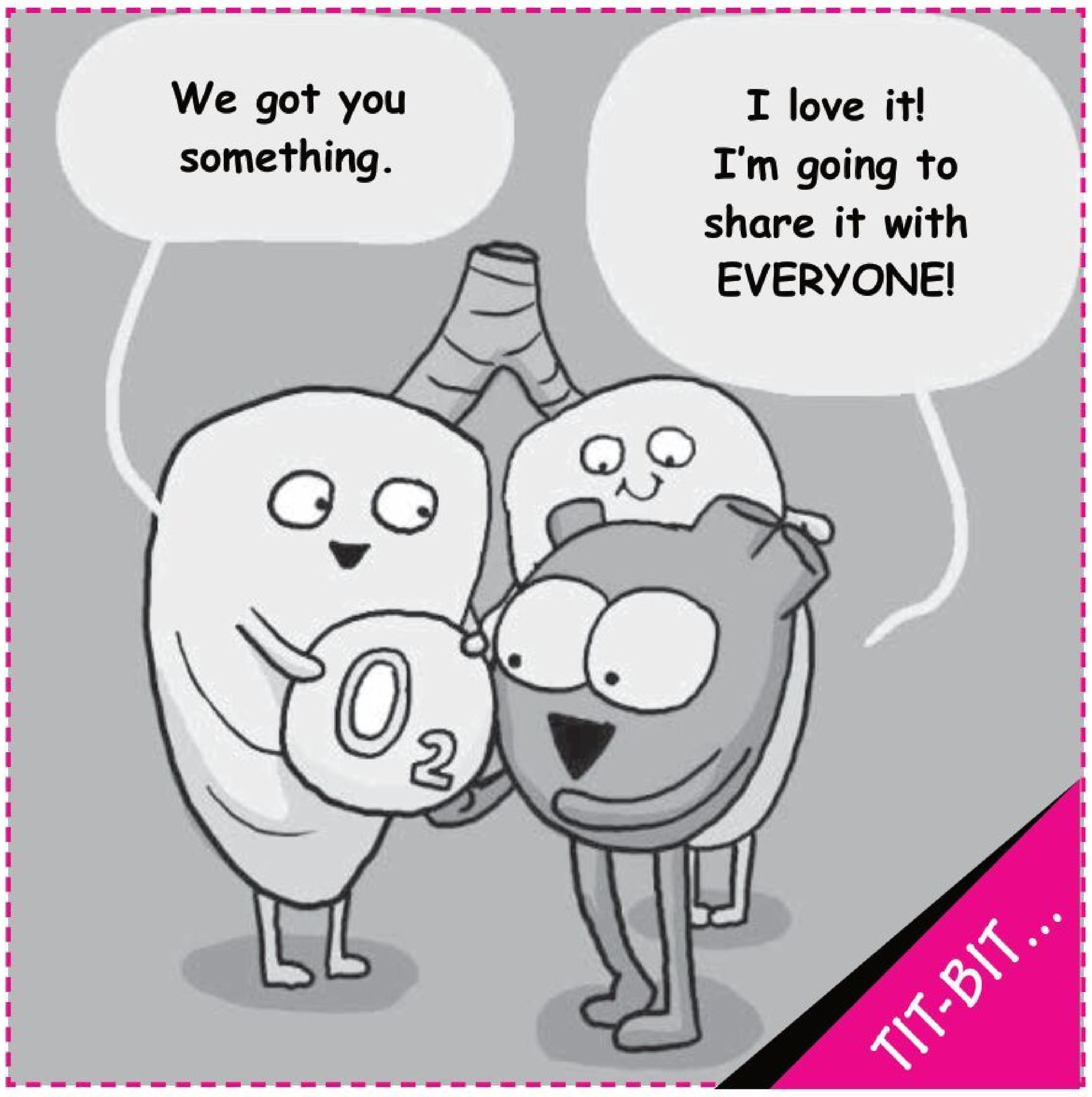
10. Which of the following changes occur in diaphragm and intercostal muscles when expiration of air takes place?
(a) Internal intercostal muscles relax and diaphragm contracts.
(b) Internal intercostal muscles contract and diaphragm relaxes.
(c) External intercostal muscles and diaphragm relax.
(d) External intercostal muscles and diaphragm contract.

11. Bohr's effect is related with
(a) reduced carbon level in lymph
(b) reduced oxygen level in haemoglobin
(c) oxidised phosphorus level in blood
(d) reduced carbon dioxide level in blood.

12. Select the incorrect statements.
(a) 97% of oxygen is carried as oxyhaemoglobin in the blood.
(b) 70% of carbon dioxide is transported as bicarbonate ions in blood plasma.
(c) 7% of carbon dioxide is transported in dissolved form in blood plasma.
(d) 5% of oxygen is transported by blood in dissolved form.

13. Read the following statements and select the correct one.
I. The volume of gas that diffuses through the membrane per minute for a pressure difference of 1 mm Hg is defined as diffusing capacity.
II. The high pCO_2 in deoxygenated blood allows the release of CO_2 from blood into the alveoli.
III. Diffusion of oxygen is 20 times faster than CO_2 and that of CO_2 is two times faster than nitrogen at the particular pressure difference.
IV. Binding of oxygen with haemoglobin is important in promoting CO_2 transport and its exchange in tissues and lungs.
(a) I, II and IV (b) II, III and IV
(c) III and IV (d) All of these

14. Which one of the following is a possibility for most of us in regard to breathing, by making a conscious effort?
(a) One can breathe out air totally without oxygen.
(b) One can breathe out air through Eustachian tube by closing both nose and mouth.
(c) One can consciously breathe in and breathe out by moving the diaphragm alone, without moving the ribs at all.
(d) The lungs can be made fully empty by forcefully breathing out all air from them.


We got you something.
I love it! I'm going to share it with EVERYONE!
O_2
TIT-BIT ...

15. Select the incorrectly matched pair.
(a) Respiratory membrane - Capillary endothelium
(b) Trachea - Ciliated cuboidal epithelium
(c) Alveoli - Squamous epithelium
(d) Larynx - Ciliated columnar epithelium

Match The Columns

16. Match the column I with column II.

	Column I		Column II
A.	Residual volume	(i)	Ratio of volume of CO_2 evolved to the volume of O_2 absorbed.
B.	Tidal volume	(ii)	Maximum volume of air that can be inhaled after a normal tidal expiration
C.	Diffusing capacity	(iii)	Volume of air inspired or expired during normal breath.
D.	Inspiratory capacity	(iv)	Volume of air remaining in lungs after forceful expiration
E.	Respiratory quotient	(v)	Limited gaseous exchange between alveoli and pulmonary blood.

17. Match the column I with column II. (There can be more than one match for items in column I.

	Column I		Column II
A.	Paranasal sinuses	(i)	Main sites of gas exchange
B.	Alveoli	(ii)	Mucosa-lined air filled cavities in cranial bones
C.	Larynx	(iii)	Produce detergent like substance called surfactant
D.	Bohr's effect	(iv)	Thyroid cartilage
E.	Pneumotaxic centre	(v)	Moistens incoming air
F.	Sneeze	(vi)	Adam's apple in males
		(vii)	Activation of pharyngeal and tracheal muscles to create large opening of nasal and oral cavities
		(viii)	Displacement of oxygen from haemoglobin due to increased CO_2
		(ix)	Limits inspiration
		(x)	Upper part of pons varolii
		(xi)	Semi-autonomous expulsion of air
		(xii)	Causes oxyhaemoglobin dissociation curve shift to right.

Passage Based Questions

18.(A) Complete the given passage with appropriate words.

The exchange of gases between lung alveoli and pulmonary capillaries is called _(i)_ respiration. It occurs through _(ii)_ membrane. This membrane consists of alveolar epithelium, epithelial basement membrane, a thin interstitial space, capillary_ basement membrane, and capillary endothelium. All these layers form a membrane of _(iii)_ mm thickness. The respiratory membrane has a limit of gaseous exchange between alveoli and pulmonary blood called _(iv)_ capacity which depends on _(v)_ of the diffusing gases. The diffusion of gases from a higher to lower concentration leads to the movement of _(vi)_ from alveoli to _(vii)_.

(B) Read the given passage and correct the errors, wherever present.

Alveoli have very thick wall consisting of cuboidal epithelium. A film of lecithin lines the alveoli of lungs that increases the surface tension and keeps the alveoli open. Exchange of O_2 and CO_2 at the alveoli and tissues occur by imbibition. The partial pressure of nitrogen is same in the alveoli as it is in the blood. Most of the air facing surfaces of alveolar wall are lined by a layer of type I and type II alveolar cells. Type I alveolar cells produce a detergent-like substance called surfactant. Surfactant increases the surface tension of water layer at alveolar surface which decreases lung compliance, thereby making it easier for the lungs to expand.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. **Assertion :** Inspiration occurs when there is a negative pressure in the lungs with respect to the atmospheric pressure.

Reason : During inspiration, a decrease in pulmonary volume increases the intra-pulmonary pressure than atmospheric pressure which forces the air from outside to move into the lungs.

20. **Assertion :** Pneumotaxic centre is located in the ventral part of pons varolii and is considered hypothetical.

Reason : The function of pneumotaxic centre is primarily to limit inspiration.

21. **Assertion :** Haemoglobin acts as a buffer and prevents the pH of blood from fluctuating.

Reason : Most of the hydrogen ions of blood are neutralised by combination with haemoglobin forming acid haemoglobin, which reduces the acidity of blood.

22. **Assertion :** Bronchitis is caused by the exposure to air pollutants like CO.

Reason : This can be treated with suitable antibiotics and bronchiodilator drugs.

23. **Assertion :** The exchange of gases between lung alveoli and pulmonary capillaries is called internal respiration.

Reason : Internal respiration lowers pO_2 of the blood and raises its pCO_2.

24. **Assertion :** Respiratory quotient for anaerobic respiration is infinity.

Reason : There is no consumption of oxygen but CO_2 is produced in most of the cases.

25. **Assertion :** Residual volume averages 1100 mL to 1200 mL.

Reason : Residual volume is the volume of air that remains in lungs after a forcible expiration.

26. **Assertion :** Mammals usually show positive pressure breathing.

Reason : Positive pressure breathing reduces work of breathing in a critically ill patient.

27. **Assertion :** External intercostal muscle is considered as the principle muscle of inspiration.

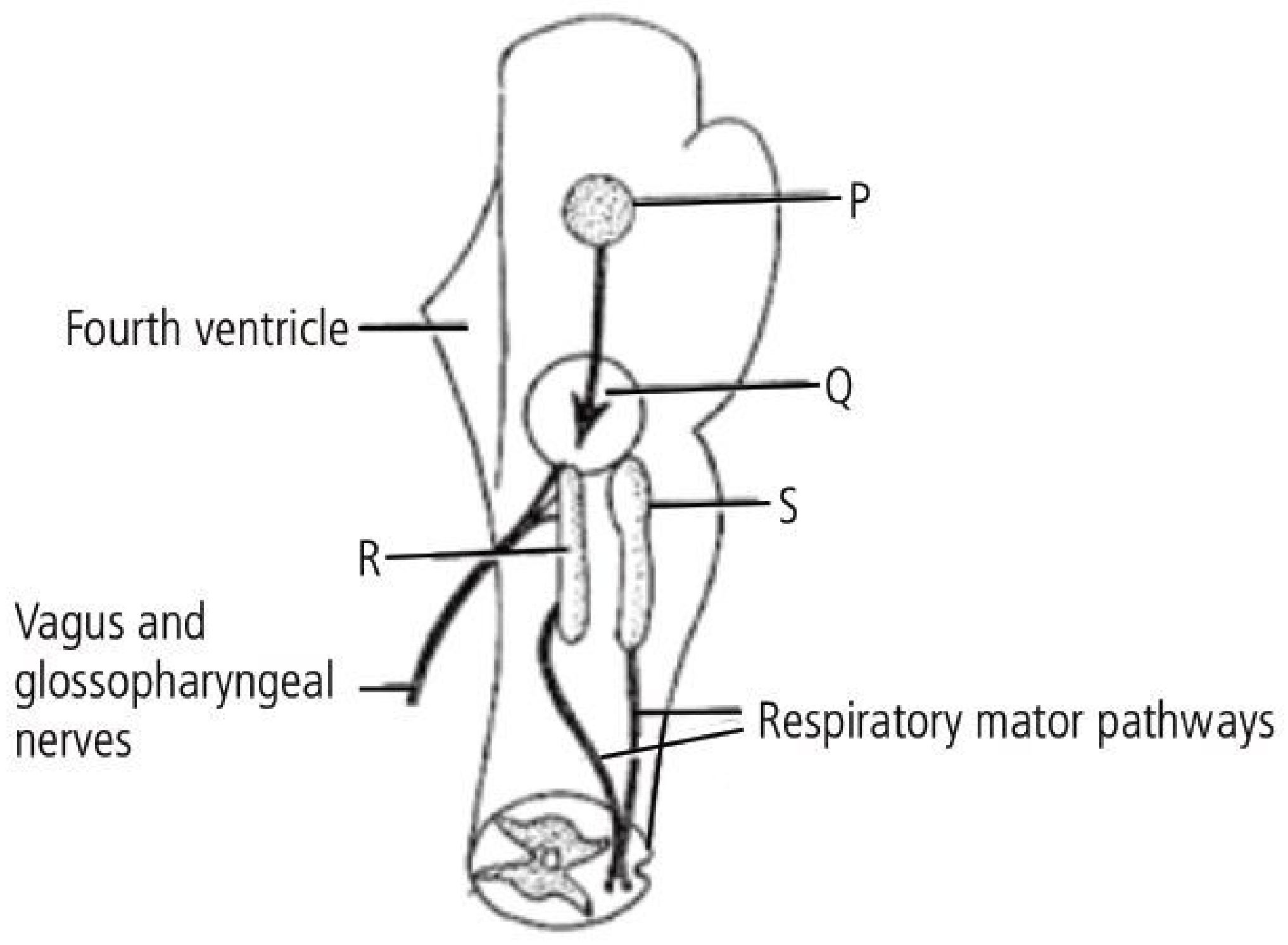
Reason : The external intercostal muscle contract to pull the ribs upward and outward increasing the volume of thoracic cavity.

28. **Assertion :** Exhalation becomes more difficult in patients of emphysema.

Reason : In emphysema patients, the surface area for gaseous exchange is greatly reduced.

Figure Based Questions

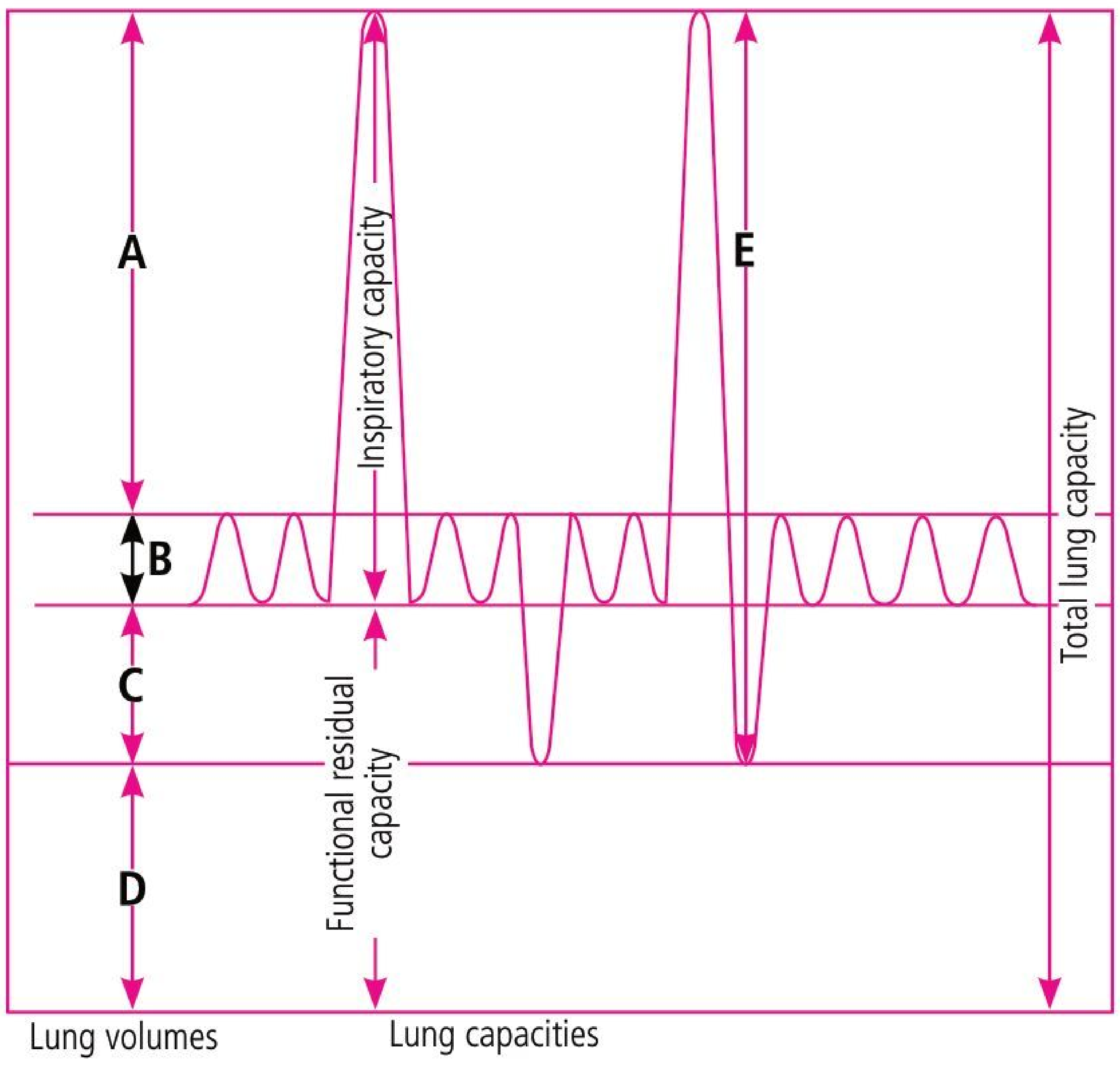
29. Refer to the given figure of respiratory centres in humans and answer the following questions.



(a) Identify P, Q, R and S in the given figure.

(b) Write one function each of P, Q, R and S.

30. Refer to the given figure showing pulmonary air volumes and capacities and answer the following questions.



(a) Identify A, B, C and D.

(b) Define D mentioned in the above figure and state its volume.

(c) Identify E and give the formula for calculating it. Suggest an example where volume of 'E' is found to be higher than normal.

SOLUTIONS

CHAPTER-16 : DIGESTION AND ABSORPTION

1.	(d)	**2.**	(a)	**3.**	(b)	**4.**	(d)	**5.**	(a)
6.	(c)	**7.**	(a)	**8.**	(c)	**9.**	(b)	**10.**	(a)
11.	(a)	**12.**	(d)	**13.**	(a)	**14.**	(c)	**15.**	(a)

16. A-(ii), B-(i), C-(iv), D-(iii)

17. A-(ii, iv), B-(v, vi), C-(viii, x), D-(iii, vii), E-(i, ix)

18.(A) (i) Stenson's (ii) mumps
(iii) Oxyntic (iv) 5
(v) Kupffer (vi) Heparin
(vii) emulsification (viii) glucagon
(ix) Paneth

(B) The ~~exocrine~~ endocrine part of pancreas consists of groups of islets of Langerhans. They are most numerous in the ~~head~~ tail of the pancreas. Each islet of Langerhans consists of alpha cells (α-cells), beta cells (β-cells) and delta cells (δ cells). Alpha cells produce ~~insulin~~ glucagon hormone which converts glycogen into glucose in the ~~stomach~~ liver. Beta cells produce ~~glucagon~~ insulin hormone which converts glucose into glycogen in the ~~duodenum~~ liver and ~~jejunum~~

muscles. Delta cells secrete ~~secretin~~ somatostatin hormone which ~~stimulates~~ inhibits the secretion of glucagon and insulin.

19. (a) **20.** (a) **21.** (d) **22.** (c) **23.** (b)
24. (c) **25.** (a) **26.** (b) **27.** (c) **28.** (a)

29. **(a)** A represents Auerbach's plexus, present in muscularis layer. Auerbach's plexus controls peristalsis.

(b) Layer B is lamina propria.

(c) C is Meissner's plexus present in submucosa layer of wall of alimentary canal.

30. **(a)** A – Oxyntic cell / parietal cell
B – Chief cells
C – Mucous cells
D – Argentaffin cell

(b) A (Oxyntic cell) secretes hydrochloric acid and Castle's intrinsic factor whereas B (chief cell) secretes digestive enzymes pepsinogen and prorennin (as proenzymes). If under certain conditions, these cells are removed from gastric epithelium, then HCl and digestive enzymes will be absent in the gastric juice. In this situation there will be no digestion of proteins present in the food in stomach and the undigested food will pass as such into the lumen of small intestine. Moreover Castle's intrinsic factor plays an important role in absorption of vitamin B_{12} in small intestine. In the absence of this factor, vitamin B_{12} absorption will be hampered.

CHAPTER-17 : BREATHING AND EXCHANGE OF GASES

1. (c) **2.** (a) **3.** (b) **4.** (a) **5.** (a)
6. (b) **7.** (d) **8.** (c) **9.** (b) **10.** (b)
11. (b) **12.** (d) **13.** (a) **14.** (c) **15.** (b)

16. A-(iv), B-(iii), C-(v), D-(ii), E-(i)

17. A-(ii, v), B-(i, iii), C-(iv,vi), D-(viii, xii), E-(ix, x), F-(vii, xi)

18. (A) (i) external (ii) respiratory
(iii) 0.2 (iv) diffusing
(v) solubility (vi) oxygen
(vii) blood

(B) Alveoli have very ~~thick~~ thin wall consisting of ~~cuboidal~~ squamous epithelium. A film of lecithin lines the alveoli of lungs that ~~increases~~ decreases the surface tension keeps the alveoli open. Exchange of O_2 and CO_2 at the alveoli and tissues occur by ~~imbibition~~ diffusion. The partial pressure of nitrogen is same in the alveoli as it is in the blood. Most of the air facing surfaces of alveolar wall are lined by a layer of type I and type II alveolar cells. ~~Type I~~ Type II alveolar cells produce a detergent-like substance called surfactant. Surfactant ~~increases~~ decreases the surface tension of water layer at alveolar surface which ~~decreases~~ increases lung compliance, thereby making it easier for the lungs to expand.

19. (c) **20.** (d) **21.** (a) **22.** (c) **23.** (d)
24. (a) **25.** (b) **26.** (d) **27.** (a) **28.** (a)

29. **(a)** P – Pneumotaxic centre
Q – Apneustic centre
R – Dorsal respiratory group of neurons
S – Ventral respiratory group of neurons

(b) P - (Pneumotaxic centre) sends signals to all the neurons of dorsal respiratory group and only to inspiratory neurons of ventral respiratory group. Its main job is to primarily limit inspiration.

Q - (Apneustic centre) works in collaboration with pneumotaxic centre to control the depth of inspiration.

R - (Dorsal respiratory group of neurons) mainly causes inspiration and controls the contraction of intercostal muscles and muscles that flatten the diaphragm to cause inspiration.

S - (Ventral respiratory group of neurons) send signals for both inspiration and expiration.

30. **(a)** A - Inspiratory reserve volume (IRV)
B - Tidal volume (TV)
C - Expiratory reserve volume (ERV)
D - Residual volume (RV)

(b) Residual volume is the volume of air which remains in the lungs even after the most forceful expiration. Its volume is about 1100 ml to 1200 ml.

(c) E is vital capacity. It is defined as the maximum volume of air a person can breathe in after a forced expiration or maximum volume of air a person can breathe out after forced inspiration.

It can be calculated as VC = TV + IRV + ERV.

(Tidal Volume + Inspiratory Reserve Volume + Expiratory Reserve Volume)

Its capacity varies from 3400 mL to 4800 mL.

Vital capacity is observed to be higher in athletes and mountain dwellers. ☺☺

MONTHLY TEST DRIVE CLASS XII ANSWER KEY

1. (a) **2.** (d) **3.** (b) **4.** (a) **5.** (b)
6. (c) **7.** (c) **8.** (a) **9.** (a) **10.** (d)
11. (d) **12.** (a) **13.** (b) **14.** (d) **15.** (d)
16. (d) **17.** (a) **18.** (c) **19.** (a) **20.** (b)
21. (b) **22.** (b) **23.** (b) **24.** (a) **25.** (a)
26. (b) **27.** (c) **28.** (a) **29.** (c) **30.** (b)
31. (b) **32.** (b) **33.** (b) **34.** (b) **35.** (c)
36. (c) **37.** (b) **38.** (a) **39.** (a) **40.** (b)

WORD GRID

Readers are requested to send their responses of word grid to be the winner.

Find and encircle the words in the given grid, running in one of the possible directions; horizontal, vertical or diagonal by reading the clues given below.

Clues

1. A condition usually seen in plants when cytokinesis fail to occur after karyokinesis resulting in an increase in whole set of chromosomes.
2. A disorder in adults caused due to excess secretion of growth hormone by pituitary gland.
3. It is a process of transfer of pollen grains from anther of one flower to the stigma of another flower of genetically different plant of same species.
4. An enzyme obtained from a microbe which is used in detergent formulations for removing oily stains from the laundry.
5. A term especially given to the fruits of mango and coconut.
6. It is the process by which anything is grouped into convenient categories based on some easily observable characters.
7. Intervening sequences within RNA that do not appear in processed RNA.
8. Asexually reproduced buds in sponge.
9. Upper part of atmosphere where good ozone is present.
10. An infectious agent that cause mad cow disease in cattle.
11. A disorder arised due to low Ca^{2+} concentration in body fluid which cause rapid spasms in muscles.
12. It is an ecological component of habitat delimited by functioning of an organism.
13. A non-staining secondary constrictions present at a constant location on few chromosomes.
14. An extrachromosomal, circular self replicating DNA.
15. Type of dentition where two sets of teeth are formed during the life of an individual.
16. A single step large mutation.
17. Epidermal hair on stem which prevent water loss due to transpiration.
18. An agent that transform normal cell into cancerous cells.
19. A phase of meiosis I where recombination between homologous chromosomes gets completed.
20. A yellow to yellow orange leaf pigment which act as an accessory pigment.

E	T	A	R	E	N	E	G	E	D	S	S	D	U	C
X	E	L	Y	O	Z	I	B	S	O	A	A	I	Z	L
C	A	R	O	T	E	N	O	I	D	L	T	P	C	A
S	H	C	P	L	A	S	M	I	D	T	E	H	C	S
T	E	T	A	N	Y	O	L	K	A	A	L	Y	A	S
R	R	I	N	T	R	O	N	A	M	T	L	O	R	I
A	P	I	S	T	I	L	D	C	P	I	I	D	C	F
T	A	B	C	T	F	T	O	R	Q	O	T	O	I	I
O	C	H	G	H	E	M	Z	O	U	N	E	N	N	C
S	H	X	E	N	O	G	A	M	Y	P	E	T	O	A
P	Y	Y	M	I	T	M	P	E	A	M	E	T	G	T
H	T	L	M	C	R	Q	E	G	N	O	X	E	E	I
E	E	E	U	H	L	I	P	A	S	E	C	P	N	O
R	N	M	L	E	Z	A	L	L	J	P	R	I	O	N
E	E	S	E	T	P	O	L	Y	P	L	O	I	D	Y

*Please send entries of solutions both with words and scanned copy of the grid within 10th of every month.

Be Lab READY!

Class XI

Experiment-1

AIM

- To study the osmosis by potato osmometer (Experiment).

REQUIREMENTS

- Fresh large sized potato tuber, beaker, 20% sucrose solution, water, petridish, peeler, pin/dissecting needle marked with waterproof ink.

THEORY

(i) **Osmosis** can be defined as 'the movement of molecules of solvent or water from the region of its higher concentration to the region of its lower concentration through a semi-permeable membrane till a state of equilibrium is reached.

(ii) Osmosis occurs due to difference in free energy of the solvent molecules in two regions. Pure water or solvent has more free energy as compared to that present in the solution. Therefore, during osmosis, solvent or water move through semi-permeable membrane from a region of its high free energy to a region of its low free energy.

(iii) The living cells are surrounded by a selectively permeable membrane and thus show osmosis when placed in water or solutions having concentration lower than the cell sap.

(iv) Water moves into the cell, when placed in pure water. It is called **endosmosis**. Water moves out of the cell, when placed in the solution having concentration higher than the cell sap. It is called **exosmosis**.

(v) The phenomenon of osmosis can be demonstrated with the help of an osmometer, *i.e.,* a device which shows osmosis.

Importance of osmosis for plants

(i) Root hairs absorb water from soil through osmosis.

(ii) Performs cell to cell movement of water in plants.

(iii) Helps to maintain turgidity of plant organs.

(iv) Resistance of plants to drought and frost brought by osmotic pressure of their cells.

(v) Involved in many types of plant movements.

PROCEDURE

(i) Peel off the outer skin of potato and cut one end flat.

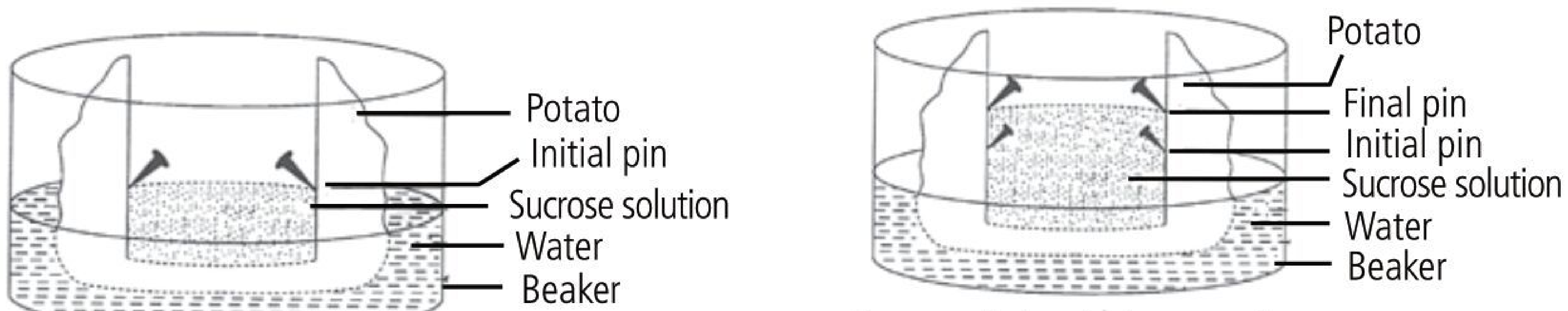
(ii) With the help of peeler make a cavity in the centre of the potato.

(iii) Fill half of the cavity of potato with 19-20% sugar solution and mark the level of sugar solution in the cavity with the help of a pin or dissecting needle. It functions as osmometer.

(iv) Leave the osmometer undisturbed for an hour in a beaker filled with water and then mark the rise in the level of sugar solution in the potato with another pin.

OBSERVATIONS

- The volume of sucrose solution inside the osmometer increases due to entry of water from the beaker as a result of endosmosis.



Initial level of sucrose in a cavity of potato

Increase in level of sucrose in cavity of potato due to osmosis

Fig. : Potato osmometer

RESULTS AND DISCUSSION

- A water potential gradient is established between the sucrose solution present in the osmometer and the external water. Although living cells of potato tuber separate these two liquids, they permit entry of water into sugar solution.

PRECAUTIONS

(i) Cavity should be deep enough to keep only a thin layer of tissues at base.

(ii) Sugar solution should be highly concentrated.

(iii) Do not damage sides and bottom of osmoscope.

VIVA-VOCE

1. Can we use salt solution instead of sugar solution?

Ans. Yes, we need to have a concentrated solution, may be a salt solution.

2. What is the need to peel off potato?

Ans. Potato skin is too thick for water to move across it.

3. Differentiate between osmosis and diffusion.

Ans.

	Osmosis	Diffusion
(i)	Osmosis can occur only in a solution.	Diffusion can occur in any medium solid, liquid or gas.
(ii)	Only solvent particles move.	Both solvent and solute particles can move, based on concentration gradient.
(iii)	Two solutions are separated by semipermeable membrane.	Two solutions are not separated by semipermeable membrane.

4. Why is the water potential of sugar solution more negative?

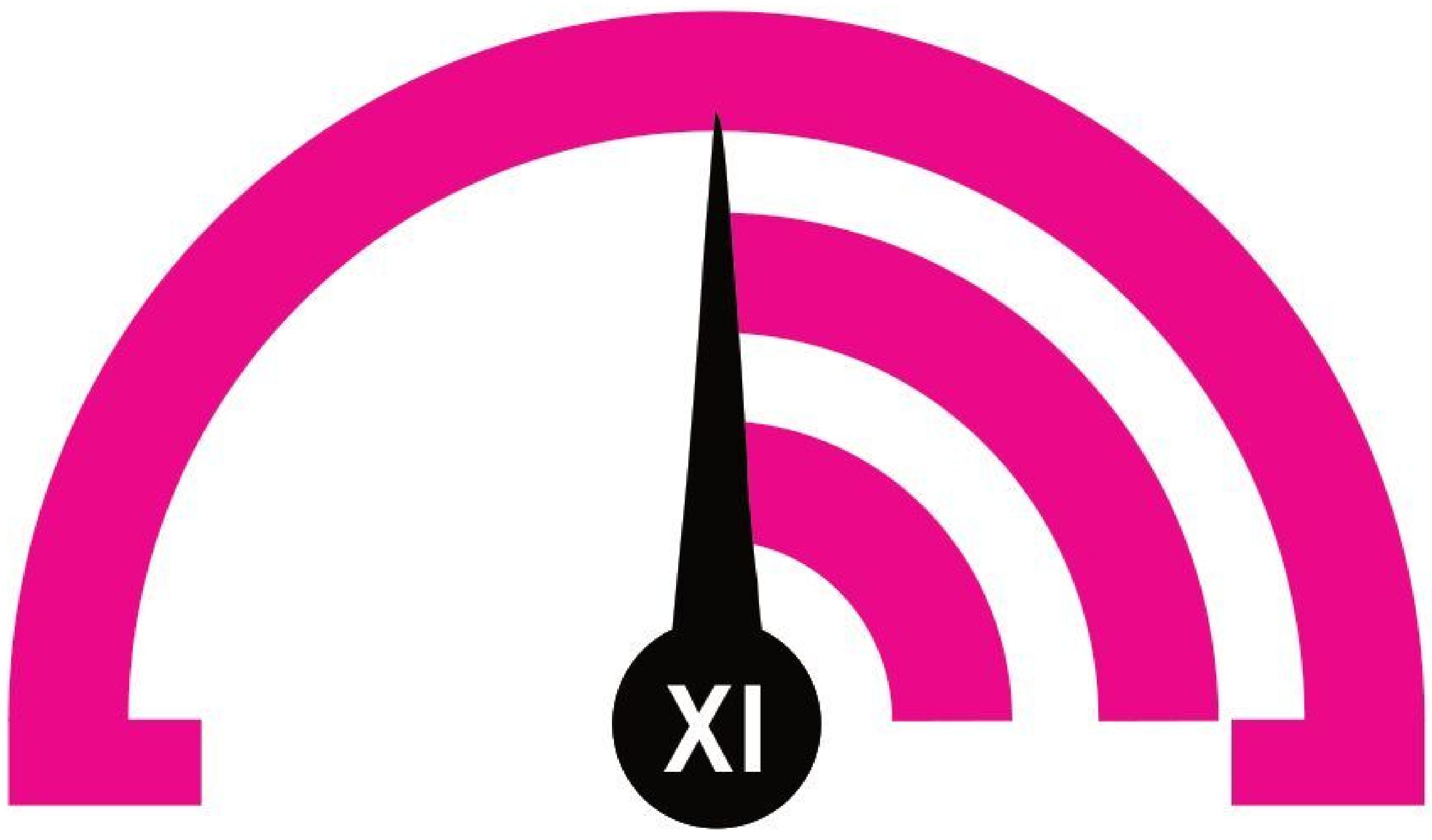
Ans. When any solute is dissolved in water, it reduces the kinetic energy of water molecules or the water concentration, therefore water potential of any solution is always less than pure water. The more the solute concentration, the more negative or lower is the solute potential.

5. What will be the rate of osmosis if we use 5% sugar solution in the osmometer?

Ans. If we use 5% solution instead of 20% solution in the potato osmometer, the rate of osmosis will decrease. This will be confirmed by decrease in the level of sugar solution in osmometer.

☺☺

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 160

Series 10 : Locomotion and Movement Neural Control and Coordination Chemical Coordination and Integration

Time : 40 Min.

1. Match Column I with Column II and select the correct option.

	Column I		**Column II**
A.	Tetany	(i)	Inflammation of joints due to accumulation of uric acid crystals
B.	Muscular dystrophy	(ii)	Auto immune disorder affecting neuromuscular junction
C.	Myasthenia gravis	(iii)	Inflammation of joints
D.	Arthritis	(iv)	Progressive degeneration of skeletal muscle due to genetic disorder
E.	Gout	(v)	Rapid spasms in muscle due to low Ca^{++} in body fluid

(a) A-(v), B-(iv), C-(ii), D-(iii), E-(i)
(b) A-(v), B-(ii), C-(iv), D-(iii), E-(i)
(c) A-(ii), B-(iii), C-(iv), D-(i), E-(v)
(d) A-(iii), B-(ii), C-(i), D-(iv), E-(v)

2. 'Fovea' is a thinned out portion of _______ where cones are densely packed.
(a) iris (b) retina
(c) choroid (d) sclera

3. The photosensitive compounds in the human eye is composed of
(a) opsin (b) retinol
(c) retinal (d) both (a) and (c).

4. The myelinated nerve fibres form a myelin sheath around the axon when they are enveloped with _____.
(a) Nissl's granules (b) ganglia
(c) Schwann cells (d) dendrites

5. 'Eustachian tube' is a connection between
(a) middle ear cavity and pharynx
(b) middle ear cavity and labyrinth
(c) labyrinth and pharynx
(d) pharynx with endolymph.

6. Identify the hormone(s) which is called as emergency hormone.
(i) Adrenaline (ii) Norepinephrine
(iii) Cortisol (iv) Insulin
(a) (i) and (ii) (b) (iii) and (iv)
(c) Only (i) (d) Only (iv)

7. Axial skeleton comprises of
(a) skull (b) ribs
(c) sternum (d) all of these.

8. 'The organ of corti' is a structure located on
(a) tectorial membrane (b) basilar membrane
(c) reissner's membrane (d) scala tympani.

9. Which of the following is a hypothalamic hormone?
(a) Prolactin
(b) Gonadotrophin releasing hormone (GnRH)
(c) Androgen
(d) Anti-diuretic hormone (ADH)

10. Given below are the characteristics of cones (a type of photoreceptor cell). Choose the incorrect statements regarding this.
(i) Daylight vision and colour vision are functions of cones.
(ii) They contain a purplish-red protein called rhodopsin.
(iii) In human eyes, there are three types of cones which respond to red, green and blue lights.
(iv) When cones are stimulated, a sensation of purple-red light is produced.
(a) (i) and (ii) (b) (i), (ii) and (iii)
(c) (i) and (iii) (d) (ii) and (iv)

11. The cerebral hemispheres are connected by tract of nerve fibres called

(a) corpus callosum (b) association areas
(c) cerebral aqueduct (d) corpora quadrigemina.

12. Read the following statements and select the correct option.
Statement I : Acetylcholine is a neurotransmitter which generates an action potential in the sarcolemma.
Statement II : Increase Ca^{++} level leads to the binding of calcium with subunit of troponin on myosin filament and remove the masking of active sites for actin.
(a) Both statements I and II are correct.
(b) Both statements I and II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

13. Identify the type of muscles on the basis of following characteristics.
(i) They have a striped appearance and are voluntary muscles.
(ii) They are non-striated and located in inner walls of hollow visceral organs.
(iii) They are the muscles of heart and are involuntary in nature.

	(i)	**(ii)**	**(iii)**
(a)	Skeletal	Cardiac	Smooth
(b)	Smooth	Cardiac	Skeletal
(c)	Skeletal	Smooth	Cardiac
(d)	Cardiac	Smooth	Skeletal

14. The saccule and utricle contain a projecting ridge called
(a) organ of corti (b) macula
(c) vestibular apparatus (d) ampulla.

15. 'Insulin' is secreted by
(a) α-cells of pancreas (b) β-cells of pancreas
(c) adrenal medulla (d) pars distalis of pituitary.

16. ________ is responsible for emotional reactions like excitement, fear, body temperature etc.
(a) Thalamus (b) Hypothalamus
(c) Pons (d) Medulla oblongata

17. 'Cretinism' is caused due to deficiency of hormone
(a) thymosin (b) thyroxine
(c) melatonin (d) oxytocin.

18. The part of the eye which contains blood vessels is
(a) choroid (b) cornea
(c) retina (d) sclera.

19. Consider the following statements and identify them as true (T) or false (F) ones.
I. Unipolar neurons are found usually in the embryonic stage.
II. Multipolar neurons consists of two or more axons and one dendrite.
III. Bipolar neurons are found in retina of eye.

	I	**II**	**III**
(a)	F	F	T
(b)	T	T	F
(c)	T	F	T
(d)	F	T	T

20. The coiled portion of labyrinth is called
(a) Eustachian tube (b) malleus
(c) pinna (d) cochlea.

21. Muscle contraction is initiated by a signal sent by the
(a) central nervous system
(b) somatic neural system
(c) autonomic neural system
(d) none of these.

22. Match Column I with Column II and select the correct option.

	Column I		**Column II**
A.	Pituitary gland	(i)	Epinephrine
B.	Pineal gland	(ii)	Follicle stimulating hormone
C.	Adrenal medulla	(iii)	Gonadotrophin releasing hormone
D.	Pancreas	(iv)	Melatonin hormone
E.	Hypothalamus	(v)	Glucagon

(a) A-(ii), B-(i), C-(iv), D-(iii), E-(v)
(b) A-(ii), B-(iv), C-(i), D-(v), E-(iii)
(c) A-(iii), B-(v), C-(i), D-(iv), E-(ii)
(d) A-(v), B-(iii), C-(ii), D-(iv), E-(i)

23. Gigantism is caused due to
(a) over secretion of growth hormone
(b) under secretion of growth hormone
(c) over secretion of luteinising hormone
(d) under secretion of luteinising hormone.

24. Scotopic vision is the function of
(a) ganglion cells (b) rods
(c) cones (d) bipolar cells.

25. Medulla oblongata contains centres which control
(a) respiration only
(b) cardiovascular reflexes only
(c) gastric secretions only
(d) all of these.

TRIO

ANSWERS DECEMBER 2022

The three letter word is **L I C**.

REP**LIC**ATION
LICHEN
FOL**LIC**LE
SP**LIC**ING

Winner : Asmita Dam (West Bengal)

26. How many metatarsals and phalanges are present in each limb?
(a) 14 and 5 respectively
(b) 5 and 14 respectively
(c) 8 and 5 respectively
(d) 14 and 8 respectively

27. There is a mechanism for generation and conduction of nerve impulse along the axon. When a stimulus is applied on the polarised membrane, that site becomes freely permeable to
(a) Ca^{++} (b) K^+
(c) Na^+ (d) Fe^{3+}.

28. Which of the following is not a part of middle ear?
(a) Incus (b) Cochlea
(c) Malleus (d) Stapes

29. Identify the incorrect statement regarding the pituitary gland.
(a) Pituitary gland is divided anatomically into an adenohypophysis and a neurohypophysis.
(b) Posterior pituitary is under the direct neural regulation of the hypothalamus.
(c) Pars intermedia of pituitary secretes only one hormone.
(d) Pars distalis region of pituitary secretes only one hormone called as vasopressin.

30. Vestibular apparatus is a complex system present in
(a) inner ear (b) middle ear
(c) thalamus (d) mid brain.

31. Which of the following statements is true about sternum?
(a) It is a flat bone on dorsal midline of thorax.
(b) It is a flat bone on the ventral midline of thorax.
(c) It articulates directly with the 8th, 9th and 10th pairs of ribs.
(d) It is joined to the 9th rib with the help of hyaline cartilage.

32. The tympanic membrane is composed of which type of tissues?
(a) Muscular tissues (b) Skeletal tissues
(c) Connective tissues (d) Epithelial tissues

33. Match the following and select the correct option.

A.	Aqueous humor	(i)	Inner ear
B.	Retinal	(ii)	Space between lens and retina
C.	Labyrinth	(iii)	Fluid between cornea and lens
D.	Vitreous chamber	(iv)	Aldehyde of vitamin A

(a) A-(iii), B-(iv), C-(i), D-(ii)
(b) A-(iv), B-(iii), C-(i), D-(ii)
(c) A-(iii), B-(iv), C-(ii), D-(i)
(d) A-(ii), B-(iv), C-(iii), D-(i)

34. The pituitary gland is located in a bony cavity called
(a) coelom (b) viscera
(c) sella tursica (d) pleural cavity.

35. Read the statements given below and select the correct one.
Statement I : Deficiency of iodine in our diet results in hypothyroidism.
Statement II : Hypothyroidism is characterised by enlargement of thyroid gland, increased basal metabolic rate, weight loss and protrusion of eye balls.
(a) Both statements I and II are correct.
(b) Both statements I and II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

36. For sense of smell, nose contains receptors named as
(a) gustatory receptors
(b) olfactory receptors
(c) photoreceptors
(d) thermoreceptors.

37. Select the type of joint which do not show any kind of movement.
(a) Synovial joints (b) Hinge joint
(c) Cartilaginous joints (d) Fibrous joints

38. The middle layer of cranial meninges called
(a) pia mater (b) arachnoid
(c) dura mater (d) corpus callosum.

39. Vitreous chamber is the space between
(a) cornea and lens (b) lens and retina
(c) sclera and retina (d) sclera and cornea.

40. Match the following and select the correct option.

A.	Diabetes mellitus	(i)	Hypothyroidism
B.	Addison's disease	(ii)	Hyperthyroidism
C.	Goitre	(iii)	Adrenal cortex
D.	Graves' disease	(iv)	Ketone bodies

(a) A-(iv), B-(iii), C-(i), D-(ii)
(b) A-(iii), B-(ii), C-(i), D-(iv)
(c) A-(iii), B-(i), C-(ii), D-(iv)
(d) A-(i), B-(iii), C-(iv), D-(ii)

☺☺

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SELF CHECK

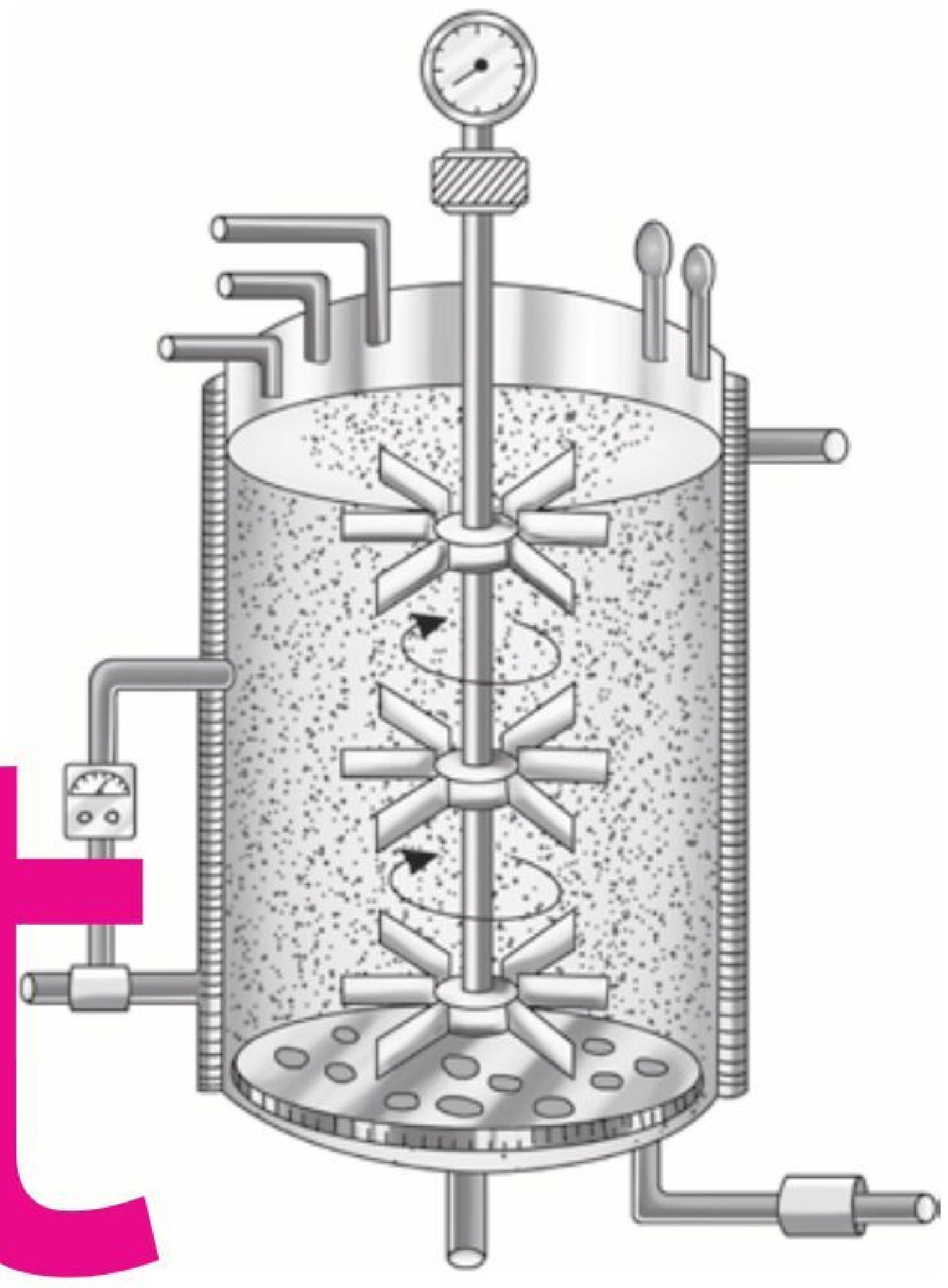
No. of questions attempted ……
No. of questions correct ……
Marks scored in percentage ……

Check your score! If your score is

> 90%	**EXCELLENT WORK !**	**You are well prepared to take the challenge of final exam.**
90-75%	**GOOD WORK !**	**You can score good in the final exam.**
74-60%	**SATISFACTORY !**	**You need to score more next time.**
< 60%	**NOT SATISFACTORY!**	**Revise thoroughly and strengthen your concepts.**

Class XII

BIO Digest



This article covers high yield facts of the given topic.

Biotechnology : Principles and Processes

- The term **biotechnology** is derived from a fusion of **biology** and **technology**. Biotechnology means any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use.
- The term biotechnology was coined in 1917 by a Hungarian Engineer, **Karl Ereky** to describe a process for large scale production of pigs.
- Biotechnology involves two common factors: the use of biological agents and the generation of product for the well being of humans.

Biotechnology

Old Biotechnology
It began as early as 5,000 BC for making wine, vinegar, curd, leavened bread, etc., by using natural capabilities of microogranisms.

Modern Biotechnology
It developed during 1970 for the production of vaccines, medicines, industrial chemicals, genetically modified organisms and food products with the help of recombinant DNA technology.

PRINCIPLES OF MODERN BIOTECHNOLOGY

- The two main techniques of modern biotechnology are:

(i) **Genetic Engineering :** It includes techniques to alter the nature of genetic material of host organism by introducing foreign or recombinant DNA into the host organism and thereby changing their phenotype.

(ii) **Chemical Engineering :** It involves maintenance of sterile, aseptive conditions, that allow growth of only the desired microorganism/eukaryotic cell in large quantities for the manufacture of biotechnological products such as antibiotics, vaccines, enzymes, medicines, hormones, etc.

- Genetic engineering deals with the manipulation of genetic material by man *in vitro*. It is based on **occurrence of plasmids** in bacteria which replicate, along with and independent of chromosomal DNA and **restriction endonuclease** which can break DNA at specific sites. Restriction endonucleases are also called as molecular scissors or biological scissors.

In 1972, genetic engineering was started by **Paul Berg.** Berg (1972) was able to introduce a gene of SV-40 virus into a bacterium with the help of lambda phage. Berg is often considered **"father of genetic engineering"**. He was awarded Nobel Prize in 1980.

- The technique of genetic engineering includes : Formation of recombinant DNA (rDNA), use of gene cloning and gene transfer.
- The first recombinant DNA was constructed by **Cohen** and **Boyer** (1972). They were able to introduce a piece of DNA carrying antibiotic resistance gene from the plasmid of *Salmonella typhimurium* into a vector plasmid. This modified plasmid was then inserted into *E. coli* to get clones of recombinant DNA.
- Three basic steps in creating genetically modified organism (GMO) or transgenic organism are:

(i) Identification of DNA with desirable genes.
(ii) Introduction of the identified DNA into the host.
(iii) Maintenance of introduced DNA in the host and transfer of the DNA to its progeny.

TOOLS OF RECOMBINANT DNA TECHNOLOGY

- There are three types of biological tools used in the formation of recombinant DNA : (i) enzymes, (ii) cloning vectors (vehicle DNA) and (iii) competent host (for transformation with rDNA).

ENZYMES

- Different kinds of enzymes used in genetic engineering are :

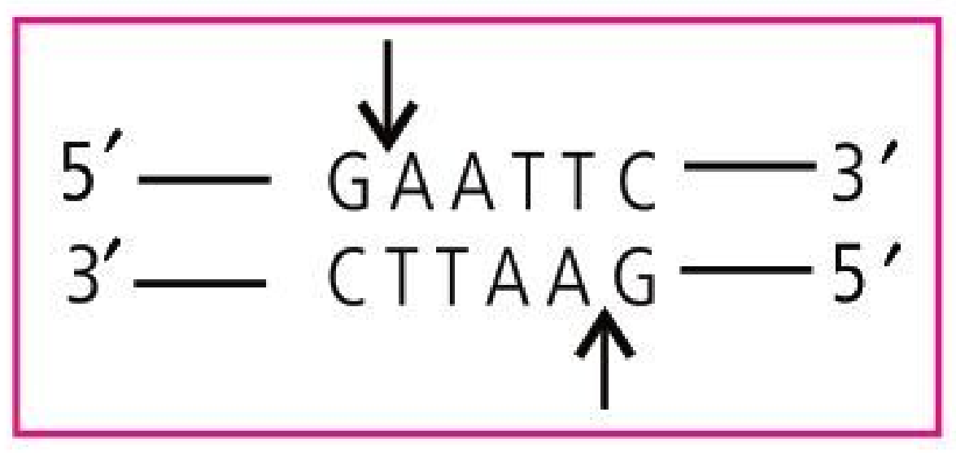
(i) **Lysing enzymes :** These enzymes are used to open up the cells to get DNA for genetic experiments. **Lysozyme** is usually used to dissolve the bacterial cell wall, cellulase for plant cell wall, chitinase for fungal cell wall, etc.

(ii) **Cleaving enzymes :** These enzymes are used to break DNA molecules at specific sites. They belong to a large class of enzymes called **nucleases**.

  - **Exonucleases :** Remove nucleotides from the terminal ends (either 5′ or 3′) of DNA in one strand of duplex.
  - **Endonucleases :** Make cuts at specific position within the DNA. These enzymes do not cleave the ends and involve only one or both strands of the DNA duplex.
  - **Restriction endonucleases :** They cut DNA duplex at palindromic sites. Their single stranded free ends are called 'sticky ends' which can be joined end to end by DNA ligase.

Restriction Endonucleases - The Molecular Scissors

- These enzymes was isolated for the first time by **W. Arber** in 1962 in bacteria. In 1978, Arber, Smith and Nathan were awarded the Nobel Prize for discovery of restriction endonucleases. These enzymes recognise the base sequence at palindrome sites in DNA duplex and cut its strand.
- The **palindromes** in DNA are base pair sequences that are the same, when read forward (left to right) or backward (right to left), from a central axis of symmetry.
- Restriction endonuclease *Eco*RI found in the colon bacteria *Escherichia coli* recognises the base sequence GAATTC in DNA duplex and cuts the DNA strands between G and A as shown above:



Nomenclature of restriction enzymes

- **Name** of the restriction enzyme is derived from the name of the source, such as bacteria ***e.g.***, ***Hind*III** enzyme has been isolated from bacteria ***Haemophilus influenzae***.
- The **first letter** of the bacterium's genus becomes the **first letter** in the name of enzyme, which is written in **capital letter** and in **italics**. The **first two letters** of the species become the **second** and **third letters** in the name of the restriction enzyme, which are written in **small letters** and are also in **italics**. The **fourth letter** in the name of the enzyme is the **letter** of the **strain,** from which the enzyme was isolated. The **Roman numeral** written at the end of the name indicates the **order**, in which the enzyme was isolated from that bacterial strain.

Functioning of restriction enzymes

- Restriction enzymes are present in many bacteria where they function as a part of their defence mechanism called the **Restriction Modification System.** Molecular basis of this system was first explained by **Wemer Arber in 1965**. The restriction modification system consists of restriction endonucleases and a modification enzyme.
- The restriction enzymes cut the strand of DNA, a little away from the centre of the palindrome sites, but between the same two bases of the opposite strands. This generates protruding 3′ or 5′ ends, *i.e.*, one strand of the double helix extends some bases beyond the other.
- Due to the palindromic (symmetrical) nature of the target sites, the two protruding ends have complementary base sequence. As a result, they can readily pair with other complementary bases of the introduced foreign DNA sequence, by forming **hydrogen bonds** due to the action of **enzyme DNA ligase**. Hence, such ends are called **cohesive** or **sticky ends.**
- Some restriction enzymes cut both the strands of a DNA molecule at the same site so that the resulting ends have **blunt ends** in which the two strands end at the same point.

Table: Some common examples of restriction enzymes, their source, recognition sequence and site of cleavage

	Restriction Enzyme	Source	Recognition Sequence and Site of Cleavage	Product
(i)	*Alu* I	*Arthrobacter luteus*	5′-A-G↓C-T-3′ 3′-T-C↑G-A-5′	A - G T - C C - T G - A Blunt ends
(ii)	*Bam*H I	*Bacillus amyloliquefaciens* H	5′-G↓G-A-T-C-C-3′ 3′-C-C-T-A-G↑G-5′	G C-C-T-A-G G-A-T-C-C G Sticky ends
(iii)	*Hind*III	*Haemophilus influenzae* Rd	5′-A↓A-G-C-T-T-3′ 3′-T-T-C-G-A↑A-5′	A T-T-C-G-A A-G-C-T-T A Sticky ends
(iv)	*Sal* I	*Streptomyces albus*	5′-G↓T-C-G-A-C-3′ 3′-C-A-G-C-T↑G-5′	G C-A-G-C-T T-C-G-A-C G Sticky ends

Other enzymes used in rDNA technology

(i) **Synthesising enzymes :** They play a role in the synthesis of DNA strands on suitable templates. They are further of 2 types:

- **Reverse transcriptase** help in the synthesis of complementary DNA strands by using *m*RNAs as a template.
- **DNA polymerase** aid in the synthesis of complementary DNA strands on DNA template.

(ii) **DNA ligases** (joining enzymes or sealing enzymes) help in sealing gaps in DNA fragments. The enzyme used most often in the rDNA technology is **T_4 DNA ligase**. These act as a **molecular glue**. They join DNA fragments by forming **phosphodiester bonds**.

(iii) **Alkaline phosphatase is** used to remove the phosphate group from the 5′ end of double or single stranded DNA or RNA. It is used to prevent unwanted self ligation of vector DNA molecules in procedure of rDNA technology.

INTEXT PRACTICE QUESTIONS

1. **Differentiate between exonucleases and endonucleases.**
2. **How does bacteria protect its own chromosomal DNA from cleavage by restriction enzymes present in them?**

Cloning Vectors (Vehicle DNA)

- The vectors are DNA molecules that can carry a foreign DNA segment and replicate inside the host cell.
- Vectors may be **plasmids, bacteriophages, cosmids, Yeast artificial chromosomes (YACs), Bacterial artificial chromosomes (BACs), transposons** and **viruses.**
- Out of these vectors, plasmid vectors and bacteriophage vectors are commonly used.

Plasmid vectors

- Plasmids are extra-chromosomal, self-replicating, usually circular, double-stranded DNA molecules, found naturally in many bacteria and also in some yeast.
- They were discovered by **William Hays** and **Joshua Lederberg** in 1952.
- Plasmids are usually not essential for normal cell growth and division, but they often confer some traits on the host organism *e.g.*, resistance to certain antibiotics.
- The plasmid molecules may be present as 1 or 2 copies or in multiple copies (500–700) inside the host organism.
- The naturally occurring plasmids have been modified *in vivo* and *in vitro* to create plasmids of enhanced utility and with specific functions.
- The most widely used, versatile, easily manipulated vector **pBR322** is an ideal plasmid vector.

pBR322 vector

- This was the **first artificial cloning vector** developed in 1977 by **Boliver** and **Rodriguez**.
- In pBR322 plasmid: **p** - denotes that it is a plasmid, **BR** - stands for Boliver and Rodriguez, who developed this plasmid and **322** - is a number given to distinguish this plasmid from others developed in the same laboratory, *e.g.*, pBR325, pBR327, pBR328 etc.

Bacteriophage vectors

- Bacteriophages are viruses that attack bacterial cells by injecting their DNA into these cells.
- The injected DNA is selectively replicated and expressed in the host bacterial cell resulting in a number of phages, which burst out of the cell (lytic pathway) and reinfect neighbouring cells.
- The most commonly used bacteriophage as cloning vectors are :
  (i) **Lambda phage vector :** It has a double-stranded, linear DNA genome of **48,502bp**, in which the 12 bases at each end are unpaired, but complementary. These ends are, therefore, sticky or cohesive and are referred to as the **cos sites (cohesive end sites)** which are important for **packaging DNA into phage heads.**
  (ii) **M13 phage vector :** This is a filamentous phage which infects *E. coli* having **F-pili**. Its genome is a single stranded, circular DNA of 6407 bp. Foreign DNA can be inserted into it, without disrupting any of the essential genes. The major advantages of developing vectors based on M13 are that its genome is less than 10Kb length, and can be purified and manipulated exactly like a plasmid.

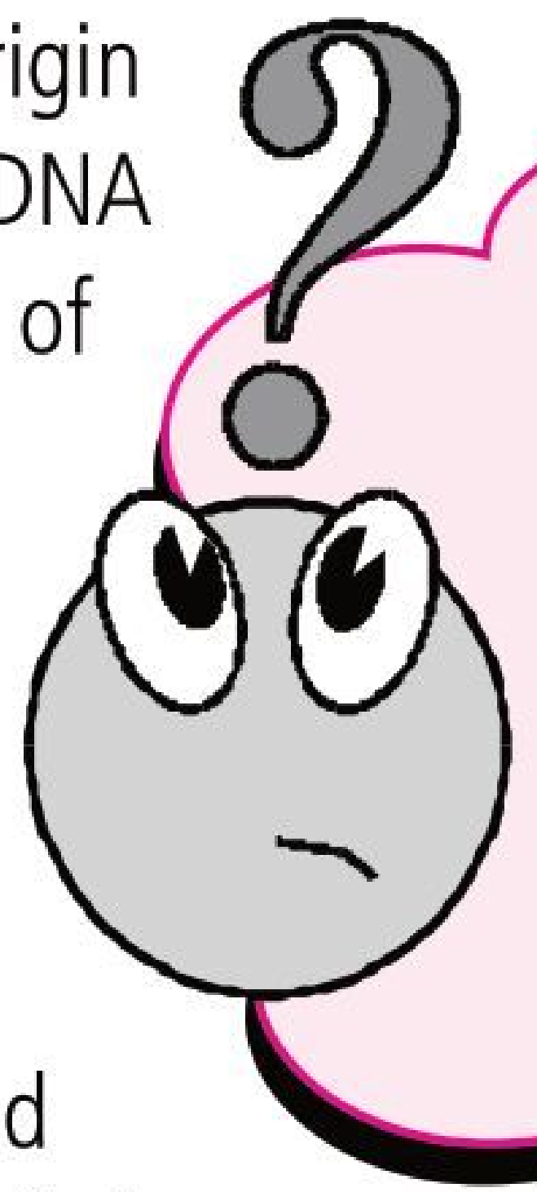
Characteristics of a cloning vector

Origin of replication *(ori)*

- This is a specific sequence from where **replication starts**, when any piece of foreign DNA is linked to this sequence.
- The replication occurs inside the host cells. This sequence is also responsible for controlling the copy number of linked DNA.
- A prokaryotic DNA has a single origin of replication, while eukaryotic DNA may have more than one origin of replication.

Selectable markers

- The vector also requires a selectable marker to identify and **eliminate non-transformants** and selectively permit the growth of the **transformants**.



WHO AM I ...

"I am a type of procedure in which separated bands of DNA are extracted from agarose gel".

...search me ☺

- Transformation is a process through which a piece of DNA is introduced in a host bacterium.
- Generally, the genes encoding resistance to antibiotics such as **tetracycline, ampicillin, kanamycin** or **chloramphenicol** etc. are useful selectable markers for *E. coli.*

Recognition or Cloning sites

- The vector must also have at least one unique restriction endonuclease **recognition site**, to enable foreign DNA to be inserted into the vector, for the generation of a recombinant DNA molecule.
- Presence of a unique restriction site allows the particular restriction enzyme to cut the vector only at that site.
- Most of the commonly used vectors contain unique recognition sites for several restriction enzymes in a small region of DNA, which is referred to as a **polylinker** or **multiple cloning site (MCS)**.
- A polylinker provides flexibility in the choice of restriction enzyme(s), that can be used for cloning.
- The ligation of alien DNA is carried out at a restriction site present in one of the two antibiotic resistance genes.

Insertional inactivation

- The inactivation of a gene by insertion of a DNA sequence (in this case, the DNA insert) within it is known as **insertional inactivation**.
- The presence of restriction sites within the markers *tet*^{R} and *amp*^{R} permits an easy selection for cells transformed with the recombinant pBR322.
- Selection of recombinants, due to inactivation of antibiotics, is a burdensome procedure, because it requires simultaneous plating on two plates having different antibiotics. So, alternative selectable markers have been developed which differentiate recombinants from non recombinants on the basis of their ability to produce colour in the presence of chromogenic substrate.

Competent Host (For Transformation with Recombinant DNA)

- Competent host is essential for transformation with the recombinant DNA. **Transformation** is a process by which a cell takes up the naked DNA fragment from its environment, incorporates it into its own chromosomal DNA, and finally expresses the trait controlled by the foreign DNA.
- Transfer of DNA into eukaryotic cell is called **transfection**. DNA transfer may be vector mediated or vectorless (direct).

A. Vector mediated gene transfer

- Since DNA is a hydrophilic molecule, it cannot pass through membranes, so the bacterial cells must be made capable to take up DNA. This is done by treating them with a specific concentration of a **divalent cation**, such as **calcium**, which increases the efficiency with which DNA enters the bacterium through pores in its cell wall.
- Recombinant DNA (rDNA) can then be forced into such cells by incubating the cells with recombinant DNA on ice, followed by placing them briefly at 42°C (heat shock) and then putting them back on ice. This process is known as heat shock treatment which enables the bacteria to take up the recombinant DNA.

B. Vectorless or direct gene transfer

- Different alternative methods have been used to introduce the recombinant DNA into recipient cells of animals, without involving a vector.

  The various methods of vectorless gene transfer are as follows:

  (i) **Gene gun or Biolistic method :** DNA is coated onto microscopic gold or tungsten particles, which are literally shot with high velocity into the target cells as microprojectiles. This technique is suitable for plants.

  (ii) **Microinjection :** In this method, foreign DNA is directly injected into the nucleus of animal or plant cell by using micro-needles or micro-pipettes. It is used in oocytes, eggs and embryos.

  (iii) **Electroporation :** In this method, electrical impulses induce formation of transient (temporary) pores in the plasma membrane of host cells by using **calcium chloride**. These pores of the membrane are the areas through which the DNA molecules are incorporated into the host cells.

  (iv) **Chemical mediated gene transfer :** Chemicals such as **polyethylene glycol (PEG)** help foreign DNA to enter the host cell.

PROCESSES OF RECOMBINANT DNA TECHNOLOGY

- The rDNA technology involves the following stages :

  (i) **Isolation of the genetic material :** Pure DNA can be obtained by treating the bacterial cells/plant or animal tissue with enzymes such as **lysozyme** (bacteria), **cellulase** (plant cells), **chitinase** (fungus). Genes are present on long DNA molecules which is interwined with proteins like histones, RNA, etc. RNA can be removed by treating with **ribonuclease**, whereas proteins can be removed by treating with **protease**.

  (ii) **Cutting of DNA at specific locations :** Purified DNA molecules are incubated with the restriction enzyme for digestion at the optimal conditions. Agarose gel electrophoresis is employed to check the progression of a restriction enzyme digestion.

  Formation of rDNA –`Gene of interest' from the source DNA and the cut vector are mixed and ligase enzyme is added. This results in the formation of recombinant DNA or hybrid DNA or chimeric DNA.

  (iii) **Amplification of gene of interest using PCR :** The Polymerase Chain Reaction (PCR) technique was invented by **Kary Mullis in 1985.** It is best defined as the DNA replication *in vitro*. It is based on the principle that a DNA molecule, when subjected to high temperature, splits into two strands due to denaturation. These single stranded molecules are then converted to original double stranded molecules by synthesising new strands, in the presence of enzyme DNA polymerase. A double stranded molecule of DNA is duplicated in this way and multiple copies of the original DNA sequence can be generated by repeating the process several times.

- **The requirements of PCR are :**

  (a) **Two nucleotide primers :** Primers are **oligonucleotides**, that hybridise to the target DNA region, one to each strand of the double helix. Two primers required are oriented with their ends facing each other allowing synthesis of the DNA towards one another.

  (b) **Enzyme :** DNA polymerase which is stable at high temperatures (more than 90°C). *Taq* polymerase is generally used in PCR reactions which is isolated from a bacterium *Thermus aquaticus*.

  (c) **DNA template :** The desired segment of the target DNA molecule that is to be amplified.

Procedure of PCR

- It involves denaturation, annealing and extension.
- In **denaturation** – the target DNA is first **heated** to a temperature between **94 - 96°C** that ensures DNA denaturation *i.e.*, the separation of the two strands also referred to as melting of DNA. Each single strand of the target DNA then acts as a template for DNA synthesis.
- During primer annealing, the mixture is now **cooled** to a temperature (generally **40-60°C**) that permits annealing of the primer to the complementary sequences in the DNA; these sequences are located at the **3′-ends** of the two strands of the desired segment.
- During primer extension (polymerisation), the temperature is now so adjusted, that the **DNA polymerase** synthesises the complementary strands by utilising 3′–OH of the primers. The primers are extended towards each other, so that the DNA segment lying between the two primers is copied. This is ensured by employing primers complementary to the 3′-ends of the segment to be amplified. The duration of primer extension is usually **2 min** at **72°C**.

- This process is repeated many times to amplify the required gene of interest. For second cycle, DNA obtained after first cycle is used as template and so on.
- **Some of the areas of application of PCR are :** detection of pathogens, diagnosis of specific mutation, DNA fingerprinting, detection of specific microorganisms, in prenatal diagnosis, diagnosis of plant pathogens, in paleontology and gene therapy.

(iv) **Insertion of rDNA into the host cell/organism :** Both direct and indirect methods are used to introduce the ligated DNA into the competent host cells. The transformed host cells are identified with the help of selective markers *e.g.*, antibiotic resistance genes.

(v) **Obtaining desirable foreign gene product :** When recombinant DNA is transferred into a bacterial, plant or animal cell, the foreign DNA is multiplied. Most of the recombinant technologies are aimed to produce a **desirable protein.**

If any protein encoding gene is expressed in a heterologous host, it is known as a **"recombinant protein"**.

After the cloning of the gene of interest, one has to maintain the optimum conditions to induce the expression of the target gene and consider producing it on a large scale.

GEL ELECTROPHORESIS

- **Gel electrophoresis** is a technique of separation of charged molecules on the basis of their size under the influence of an electrical field, so that they migrate in the direction of electrode bearing the opposite charge, through a medium/matrix.
- The most commonly used matrix is **agarose** which is a polysaccharide extracted from sea weeds.
- The separated DNA fragments can be seen only after staining DNA with a compound **ethidium bromide (EtBr),** as bright orange coloured bands on exposure to UV radiations.
- The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece. This step is called as **elution**.

INTEXT PRACTICE QUESTIONS

3. **What is the role of enzyme *Taq* polymerase in gene amplification?**
4. **Which technique is used for separation of DNA fragments? Also name the type of matrix used in this technique.**

BIOREACTORS (FERMENTORS)

- Bioreactors are considered as vessels in which raw materials are biologically converted into specific products by microbes, plant and animal cells or their enzymes.
- Small volume cultures cannot give large quantities of the products. To produce large quantities of these products, bioreactors are required where large volume (100 - 1000 litres) of culture can be processed.
- Bioreactor provides the optimal conditions for obtaining the desired product by providing optimum growth conditions such as temperature, pH, substrate, vitamins, oxygen and salts.
- Stirring type of bioreactors are most commonly used. A bioreactor (fermentor) has a provision for **batch culture** or **continuous culture.**
- In continuous culture, the culture medium is added continuously as it is utilised and the product is taken out, while in batch culture, the nutrients and microbes are added in closed chamber and are not changed once the fermentation starts.
- **Stirring type of bioreactors include :**

(i) **Simple stirred tank bioreactor :** It is a large stainless steel vessel, which has the main parts as cooling jacket, air inlet and filter, stirrer, sparger, nutrient, antifoam, inoculum, pH and dissolved oxygen lines, temperature sensor and control unit. Most fermentors are **aerobic** and require a large volume of sterile air through **air inlet and filter. Cooling jacket** reduces temperature because the culture generates heat during growth. **Stirrer** consists of a vertical rotating **stirrer shaft** and flat, vertical **stirrer blades**.

- The significance of this bioreactor is that the microorganisms turn raw materials into products such as glucose into alcohol through fermentation. It is easily used in research laboratories. It also controls monitoring of physical, chemical and biological parameters.
- The main drawback in simple stirred tank bioreactor is that it is **relatively expensive** to run it, which is mainly due to high energy requirements to drive the agitators.

(ii) **Sparged stirred tank bioreactor :** In the sparged stirred-tank bioreactor, **sterile air bubbles** are sparged. The surface area for oxygen transfer is hence increased.

- After formation of the product in bioreactors, it undergoes through a series of processes, like separation and purification (collectively known as **downstream processing**) before it is ready for marketing as a finished product.
- The product has to be formulated with suitable preservatives.
- Such formulation has to undergo through clinical trials as in case of drugs. Strict quality control testing for each product is also required.
- The downstream processing and quality control testing varies from product to product.

Biotechnology and Its Applications

- Biotechnology mainly employs molecular biology techniques and genetics to create improved genetically modified products. It deals with industrial scale production of biopharmaceuticals and biologicals using genetically modified microbes, fungi, plants and animals.
- Biotechnology shows development and applications in various fields such as food and agriculture, human health and medicine, industrial production, environment, etc.
- The diverse applications of biotechnology in various fields have led to emergence of different branches of biotechnology such as red biotechnology (medical biotechnology), green biotechnology (in agricultural sector), white biotechnology (industrial sector) and blue biotechnology (related to marine and other aquatic organisms).

BIOTECHNOLOGICAL APPLICATIONS IN AGRICULTURE

- Ever increasing population, imposed new challenges over the agriculture sector by increased demand of food. One of the solutions to overcome this problem is use of genetically modified crops.
- The organisms that have been manipulated genetically are called genetically modified organisms. They can be plants, animals or microbes.

Genetically Modified Crops

- Genetically modified crop plants contain and express one or more useful, desirable foreign genes. Genes incorporated into an organism's genome are called transgenes and the plant expressing the product of transgene are called transgenic plants.

Production of Transgenic Plants

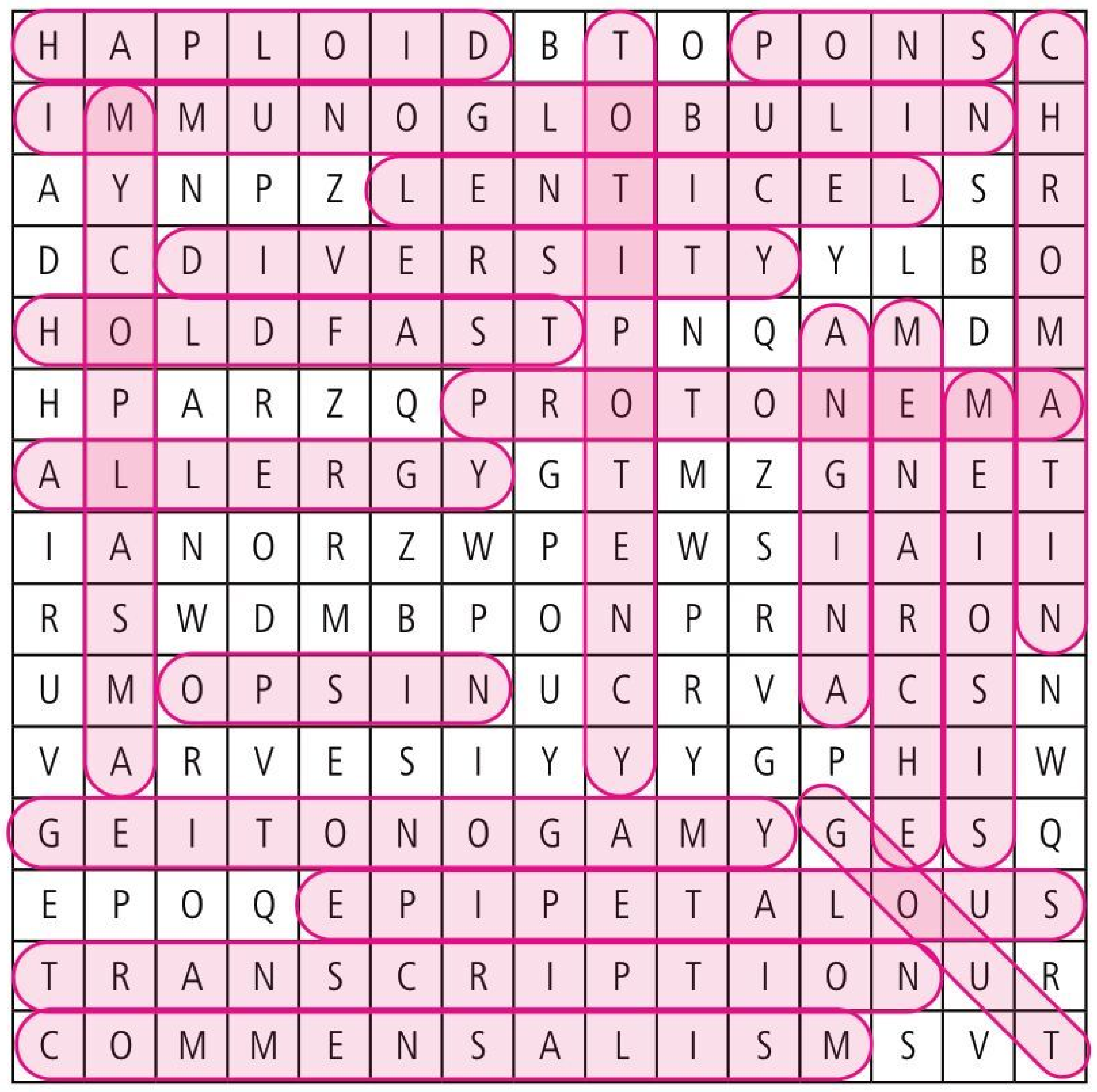
- The vector used to introduce new genes into plant cells is most often a plasmid from soil bacterium *Agrobacterium tumefaciens*. Since the plasmid possesses genes that transfer the DNA from plasmid and gets integrated into host (plant genome), it is called natural genetic engineer. The plasmid induces tumors in broad leaf plants such as tomato, tobacco, soybean, etc., hence is also referred to as **tumor inducing plasmid (Ti plasmid)**. Few examples of transgenic plants are:

Insect resistant plants

- Soil bacterium *Bacillus thuringiensis* produces proteins that kill certain insects like lepidopterans (tobacco budworm, armyworm), coleopterans and dipterans (flies, mosquitoes).
- Bacteria produces protein crystals containing inactive toxin (protoxins). Hence, these toxins do not harm the bacteria, but kill insects when they ingest plant parts expressing

Contributed by : *Avirupsa Dolui, (Midnapur, West Bengal)*

SOLUTIONS TO DECEMBER 2022 WORD GRID



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H	O	L	D	F	A	S	T	P	N	Q	A	M	D	M
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E	P	O	Q	E	P	I	P	E	T	A	L	O	U	S
T	R	A	N	S	C	R	I	P	T	I	O	N	U	R
C	O	M	M	E	N	S	A	L	I	S	M	S	V	T

1. Immunoglobulin
2. Epipetalous
3. Haploid
4. Diversity
5. Mycoplasma
6. Opsin
7. Meiosis
8. Holdfast
9. Protonema
10. Lenticel
11. Pons
12. Geitonogamy
13. Angina
14. Gout
15. Menarche
16. Chromatin
17. Transcription
18. Allergy
19. Totipotency
20. Commensalism

them. Alkaline pH of alimentary canal of insect, solublises the crystal and converts inactive protoxins into active toxins.

- Through genetic engineering, these Bt toxin genes were isolated and incorporated into several crop plants as tobacco, cotton, corn, etc.
- The choice of gene depends upon the crop and its target pest, as most of the toxins are pest or insect group specific.
- ***cry* genes** : In Bt cotton, *cry* I Ac and *cry* II Ab provide resistance against cotton bollworms. In Bt corn, *cry* I Ab provides resistance against corn borer.

Pest resistant plants

- A nematode *Meloidogyne incognita* infests the roots of tobacco plants and causes a great reduction in yield. A novel strategy was adopted to prevent this infection that was based on the process of **RNA interference (RNAi)**. RNA interference is the phenomenon of **inhibiting activity of a gene through production of sense and antisense RNA**.
- This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing).
- The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate *via* an RNA intermediate.
- Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant. The introduction of DNA was such that it produced both sense and anti-sense RNA in the host cells. These two RNA's being complementary to each other formed a double stranded (dsRNA) that initiated RNAi and thus, silenced the specific *m*RNA of the nematode.
- The result was that the parasite could not survive in a transgenic host expressing specific interfering RNA. The transgenic plants thus, got itself protected from the parasite.

Other agricultural applications

- Some other agricultural applications are :
  - The protein **hirudin** prevents blood clotting. Its gene was chemically synthesised and introduced in *Brassica napus*. The seeds of the latter came to have hirudin which could be extracted and purified and used as medicine.
  - '**Flavr Savr**' tomato was the first transgenic variety to reach the market. Here inactivation of gene which produces **polygalactouronase enzyme** has been done. The non-availability of this enzyme prevents over-ripening because this enzyme is essential for degradation of cell walls.
  - **Golden rice** is a transgenic variety of rice (*Oryza sativa*) which contains good quantities of β-carotene (provitamin A – inactive state of vitamin A).

BIOTECHNOLOGICAL APPLICATIONS IN MEDICINE

- The recombinant DNA technological processes have made great impact in the area of healthcare by mass production of safe and more effective therapeutic drugs. A large number of human genes encoding pharmaceutically valuable proteins have been cloned and expressed in microorganisms. Initially, *E. coli* was used as the host for obvious reasons of ease in cloning. But yeast is fast becoming the host of choice for production of **recombinant proteins.**

Production of Genetically Engineered Insulin

- Human insulin is made up of 51 amino acids arranged in two polypeptide chains, **A** having **21 amino acids** and **B** with **30 amino acids.** The two polypeptide chains are interconnected by two disulphide bridges or **S-S linkages.** An S-S linkage also occurs in A chain.
- In mammals, including humans, insulin is synthesised as a pro-hormone which contains an extra stretch called the **C peptide** (with 33 amino acids). This C peptide is not present in the mature insulin and is removed during maturation into insulin. The pro-hormone needs to be processed before it becomes a fully mature and functional hormone. Bacteria cannot be made to synthesise insulin from its gene because of the presence of introns in eukaryotic genes. Bacteria do not possess enzymes for removing introns. It was challenging to produce insulin using *r*DNA technique and to assemble insulin into its mature form.
- In 1983, **Eli Lilly,** an American company, prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E.coli* to produce insulin chains. Chains A and B were produced separately, extracted and combined by creating disulphide bonds to form **human insulin ('Humulin').**

WHO AM I ...

"I am an official license to use a particular biological material for commercial exploitation".

...search me ☺

GENE THERAPY

- **Gene therapy** is the technique of genetic engineering to replace a faulty gene by a normal healthy functional gene. The first clinical gene therapy was given in 1990 to a 4-year old girl with **adenosine deaminase (ADA) deficiency**. This enzyme is very important for the immune system to function. **SCID** is caused due to defect in the gene for the enzyme adenosine deaminase. ADA deficiency can be cured by bone marrow transplantation and by enzyme replacement therapy, in which functional ADA is given to the patient by injection. But in both approaches the patients are not completely cured. However, if the isolated gene from bone marrow cells producing ADA is introduced into cells at early embryonic stages, it can be a permanent cure.

Molecular Diagnosis

- For effective treatment of a disease, early diagnosis and understanding its pathophysiology is very important. Using conventional methods of diagnosis (serum and urine analysis, etc.) early detection is not possible. **Recombinant DNA technology, Polymerase chain reaction** (PCR) and **Enzyme linked immunosorbent assay** (ELISA) are some of the techniques that serve the purpose of early diagnosis.
- Presence of a pathogen (bacteria, viruses, etc.) is normally suspected only when the pathogen has produced a disease symptom. By this time the concentration of pathogen is already very high in the body. However, very low concentration of a bacteria or virus (at a time when the symptoms of the disease are not yet visible) can be detected by amplification of their nucleic acid by PCR.
- **PCR** is now routinely used to **detect HIV** in suspected AIDS patients. It is being used to detect mutations in genes in suspected cancer patients too. It is a powerful technique to identify many other genetic disorders.
- A single stranded DNA or RNA, tagged with a radioactive molecule (probe) is allowed to hybridise to its complementary DNA in a clone of cells followed by detection using autoradiography. The clone having the mutated gene will hence not appear on the photographic film, because the probe will not have complementarity with the mutated gene.
- **Enzyme linked immunosorbent assay (ELISA)** is based on the principle of **antigen - antibody interaction.** Infection by pathogen can be detected by the presence of antigens such as proteins, glycoproteins, etc., or by detecting the antibodies synthesised against the pathogen.

Boon for Solving Cases

- Biotechnology has proved to be a **boon in solving crimes**, legal disputes, etc. Establishing the identity of victims (*e.g.*, of murder, accidents, etc.), criminals (*e.g.*, in cases of rape, murder, etc.), father (in cases of paternity dispute), etc. to solve the problems of crimes/cases.

INTEXT PRACTICE QUESTIONS

5. Explain the process of RNA interference.
6. What is gene therapy ? Also mention the first clinical case in which it was used.
7. How rDNA technology is applied in the production of insulin?

Biotechnological Applications in Industry

- The exploitation of microorganisms for industrial production of useful products began as early as 1875 with the production of alcohol.
- At present, several chemicals, such as lactic acid (1881), amylase (1884), glycerine (1914), citric acid (1923), gluconic acid (1928), acetic acid, acetone, butanol, a variety of enzymes, vitamins, amino acids and all the antibiotics are produced using microorganisms.
- Some common industrial enzymes such as α- amylase, cellulase, lipase (Source *Aspergillus* sp) are used during production of alcohol, flavour modification, etc.

TRANSGENIC ANIMALS

- A transgenic animal contains in its genome, a gene or genes introduced by one or the other technique of transfection. The gene introduced by transfection is known as **transgene**.

Production of Transgenic Animals

- The **foreign genes** are inserted into the genome of the animal using recombinant DNA technology.
- The production of transgenic animals includes following steps :
  - Identification and isolation of desired gene
  - Selection of a proper vector (usually a virus) or direct gene transfer

  - Insertion of gene within the vector
  - Introduction of recombinant vector into the host cells, tissues of embryo or mature individual
  - Demonstration of integration and expression of foreign gene in transgenic tissue or animal

Applications of Transgenic Animals

- Transgenic animals are produced for the following purposes:
  - **Production of biological products :** Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product. Such as human protein (α-1-antitrypsin) obtained from transgenic animal is used to treat emphysema.
  - **Testing vaccine safety :** Before being used on humans, transgenic mice are used to test safety of newly developed vaccines.
  - **Study of physiology and development :** Transgenic animals are developed to study how genes are regulated and how they affect normal functions of body and its development.
  - **Study of diseases :** Transgenic animals act as models for study and understanding of causes and possible treatments of disease in concern *e.g.*, cancer, cystic fibrosis, Alzheimer's disease.
  - **Replacement of defective parts** with freshly grown parts from own cells or transgenic animals.
  - **Production of clones** of animals with desirable traits.
- Some examples of transgenic animals are : ANDI (transgenic monkey), Rosie (transgenic cow), transgenic mice and rabbits.

ETHICAL ISSUES

- Ethics include rules of conduct by which a community regulates its behaviour and decides as to which activity is lawful and which is not.
- Bioethics is the branch of ethics, philosophy and social commentary that deals with the biological sciences and their potential impact on society.
- The main bioethical concerns pertaining to biotechnology are briefly mentioned as follows:
  - Introduction of a transgene from one species into another species **violates the 'integrity of species'.**
  - Biotechnology may pose unforeseen risks to the environment, including risk to biodiversity. Thus, it could **disturb the existing ecological balance.**
  - Transfer of human genes into animals (and *vice-versa*) **dilutes the concept of 'humanness'.**
  - **Use of animals** in biotechnology causes great suffering to them.
  - Scientists cannot rule out the possibility of other **biological damage.** It can accidentally create new infectious agents.
  - When animals are used for production of pharmaceutical proteins, they are virtually reduced to the **status of a 'factory'**.
  - It is disrespectful to living beings, and only exploits them for the **benefit of human beings.**

BIOPIRACY

- It is exploitation of bioresources of a country by organisations or multinationals for commercial exploitation, specially by obtaining patents that restrict its future use, while failing to pay fair compensation to community from where it originates.
- Bioresources or biological resources are all those organisms which can provide commercial benefits. They are abundant in developing countries which are poor in technology though the countries have traditional knowledge related in bioresources.
- There has been growing realisation of the injustice, inadequate compensation and benefit sharing between developed and developing countries. Therefore, some nations are developing laws to prevent such **unauthorised exploitation** of their bioresources and traditional knowledge.
- There have been incidences where certain companies get the patents for products and technologies which involve the use of the genetic materials, plants and other biological resources that have long been identified, developed and used by farmers and indigenous people of a specific region/country.

Three Aspects of Biopiracy

- **Intellectual piracy:** This makes a false claim to novelty and invention, even though the knowledge has evolved since ancient time.
- **Resource piracy:** This divests scarce biological resources to monopoly control of corporations thus depriving communities and indigenous practitioners.
- **Economic piracy:** It creates market monopolies and excludes the original innovators from their rightful share to local, national and international markets.

BIOPATENT

- A **patent** is the right granted by a government to an inventor to prevent others from commercial use of his invention. When patents are granted for biological entities and for products derived from them, these patents are called **biopatents**. Patents have been taken out on plants such as black pepper (*Piper nigrum*), basmati rice (*Oryza sativa*), Indian mustard (*Brassica campestris*), pomegranate (*Punica granatum*), turmeric and neem.

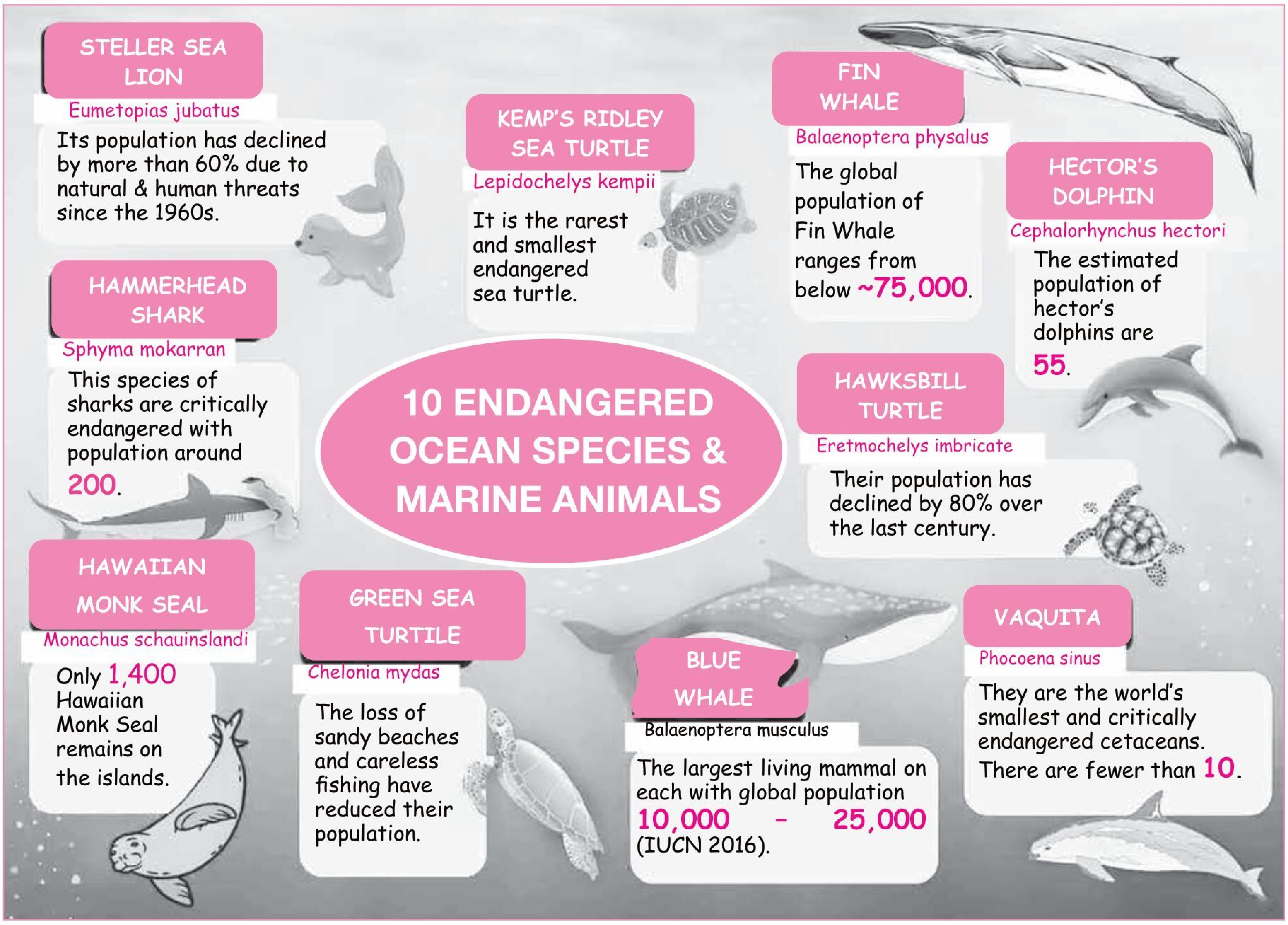
BIOWAR

- It is the use of highly infectious pathogens, their spores and toxins as agents of biological weapons against humans, crops and animals of enemy country.
- The agent **(virus, bacterium, fungus, spores, toxin)** is kept in a special container that keeps it in active/virulent state during delivery by missile or aircraft.
- Spray and powder are two common forms in which the bioweapon agent is delivered.
- Potential pathogens for bioweapons are *Bacillus anthracis*, *Vibrio cholerae*, small pox virus *Pasteurella/Yersinia pestis*, botulinum toxin, etc.
- Bioweapons are almost invisible, low cost weapons which can cause more casualities than conventional or chemical weapons. Possible defence against them is gas mask or respirator, protective shelter, vaccination, antibiotics, decontamination and sensitive detection systems.

INTEXT PRACTICE QUESTIONS

8. Briefly explain transgenic animals with examples.

9. Name some pathogens for bioweapons.



10 ENDANGERED OCEAN SPECIES & MARINE ANIMALS

STELLER SEA LION
Eumetopias jubatus
Its population has declined by more than 60% due to natural & human threats since the 1960s.

KEMP'S RIDLEY SEA TURTLE
Lepidochelys kempii
It is the rarest and smallest endangered sea turtle.

FIN WHALE
Balaenoptera physalus
The global population of Fin Whale ranges from below ~75,000.

HECTOR'S DOLPHIN
Cephalorhynchus hectori
The estimated population of hector's dolphins are 55.

HAMMERHEAD SHARK
Sphyma mokarran
This species of sharks are critically endangered with population around 200.

HAWKSBILL TURTLE
Eretmochelys imbricate
Their population has declined by 80% over the last century.

HAWAIIAN MONK SEAL
Monachus schauinslandi
Only 1,400 Hawaiian Monk Seal remains on the islands.

GREEN SEA TURTILE
Chelonia mydas
The loss of sandy beaches and careless fishing have reduced their population.

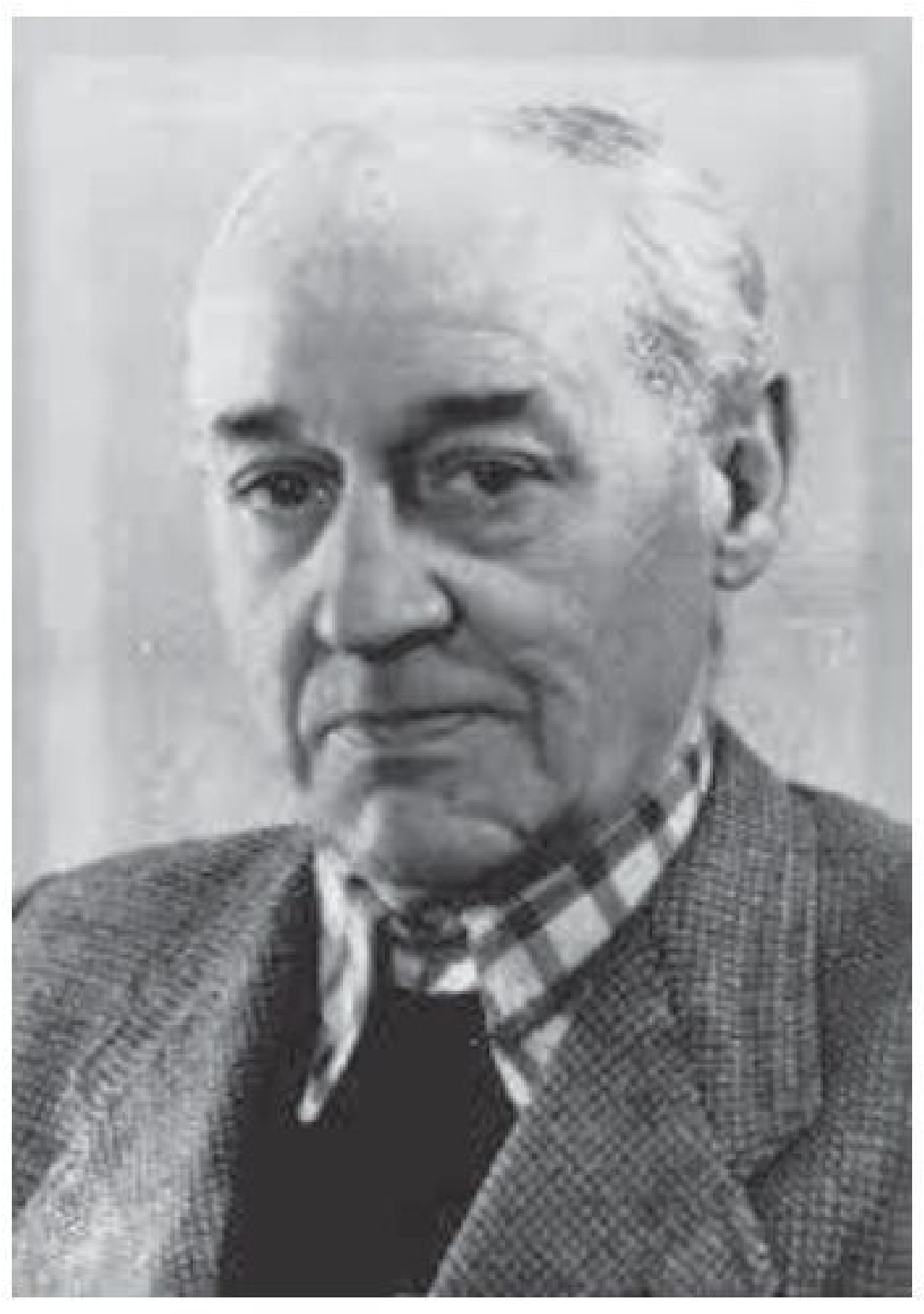
BLUE WHALE
Balaenoptera musculus
The largest living mammal on each with global population 10,000 - 25,000 (IUCN 2016).

VAQUITA
Phocoena sinus
They are the world's smallest and critically endangered cetaceans. There are fewer than 10.

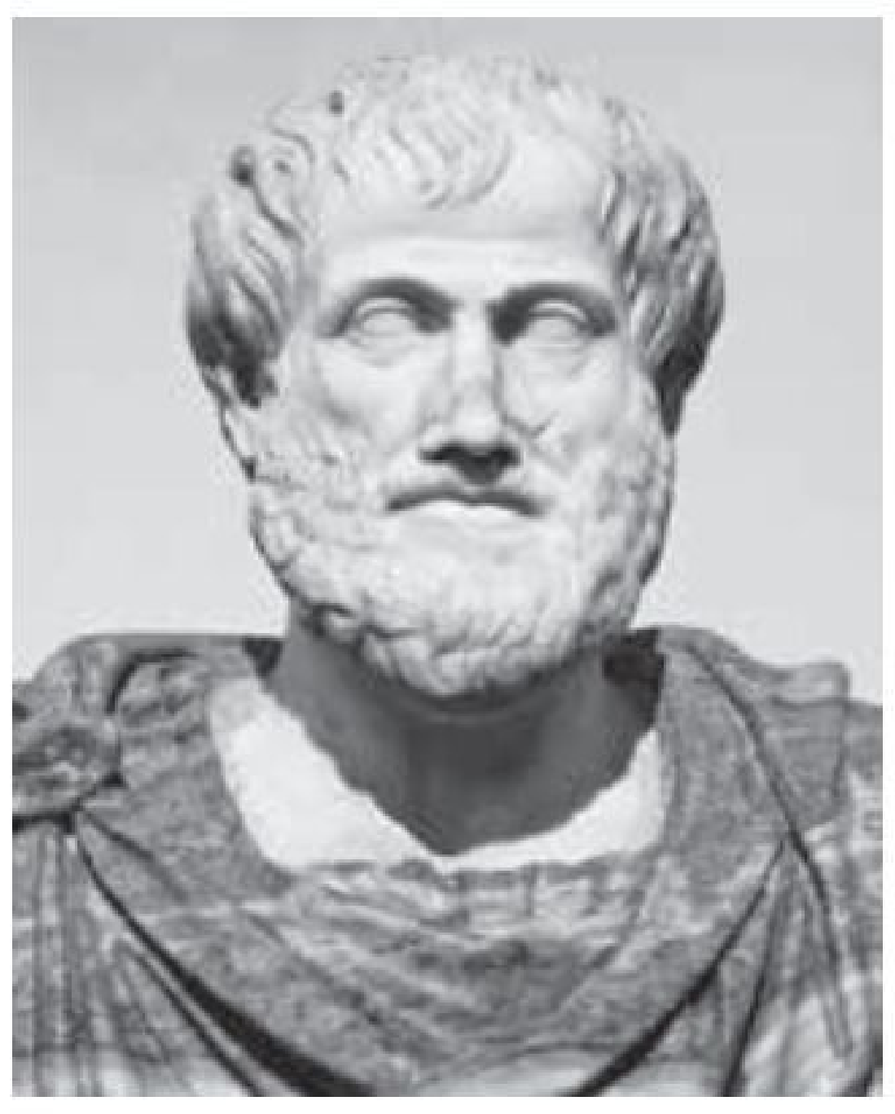
Quiz CLUB

Unlock Your Knowledge!

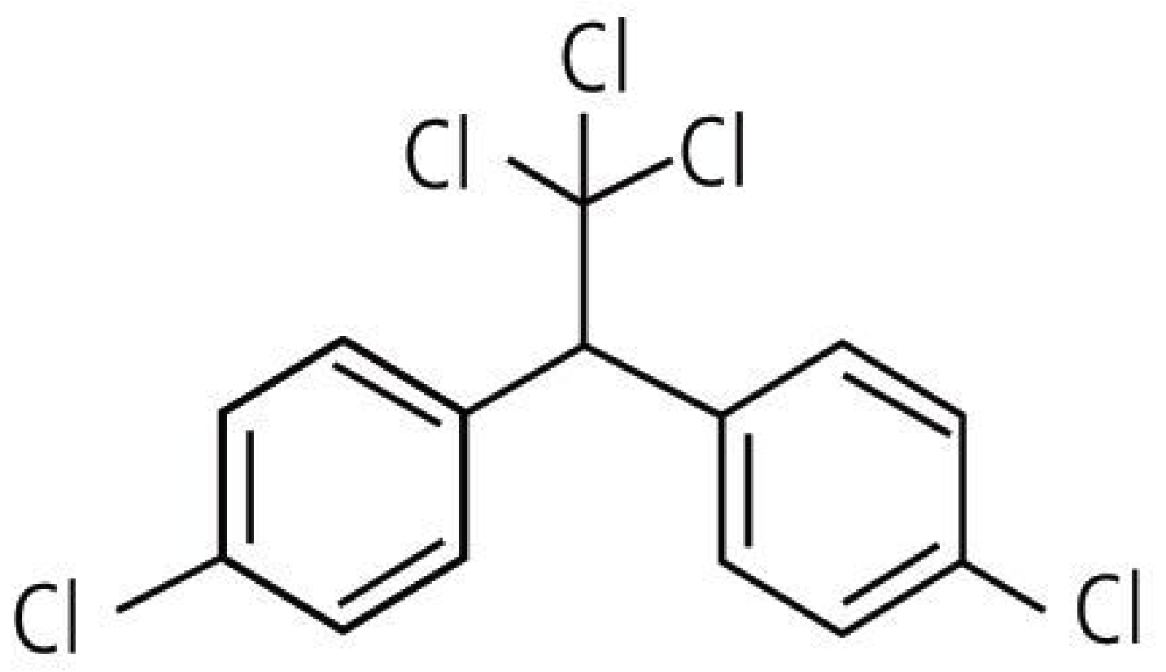
1. A group of dog offspring is known as
2. Monarch, Red admiral , Green hairstreak, Grayling are types of________.
3. Who perform waggle dance to communicate with other mates in food search?
4. Hansen's disease is more commonly known by which name?
5. How many neck vertebrae do giraffes have, compared to a human's?
6. Age of fishes was known as________.
7. Which acid is found in tomato?
8. Which one is the largest artery in the human body?
9. Which organism shows the presence of chevron bone?
10. Which term was first used by the scientist shown?



11. How many nerve cells are present in the human brain?
12. Name the term given to disease that transmits from animals to humans.
13. The only living reptiles that use a vertical limb posture in walking is ________.
14. Spermology is the study of ________.
15. Who is the personality in the given image?



16. 13 - chambered heart occurs in ________.
17. The plant dye henna imparts orange-red colour to skin and hairs due to its reaction with which macromolecule?
18. Which of the following eye disorders is known as 'lazy eye'?
19. What is name of the given compound?



20. Wooden doors are difficult to open or close during rainy season due to
21. Only movable bone in the skull is________.
22. Viticulture is related with________.
23. An area of dead myocardial tissue is called________.
24. Female frog do not produce croacking sound because of absence of which organ?
25. Which cells get destroyed by polio virus?

☺☺

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

CBSE warm-up!

CLASS-XII

Chapterwise practice questions for CBSE Exams as per the latest pattern and reduced syllabus by CBSE for the academic session 2022-23.

Series-5

- **Organisms and Populations**
- **Ecosystem**
- **Biodiversity and Conservation**

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions. All questions are compulsory.
(iii) Section–A has 16 questions of 1 mark each; Section–B has 5 questions of 2 marks each; Section– C has 7 questions of 3 marks each; Section– D has 2 case-based questions of 4 marks each; and Section–E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat and properly labelled diagrams should be drawn.

Time Allowed : 3 hours **Maximum Marks : 70**

SECTION-A

1. Which type of pyramid is always upright?
(a) Number (b) Biomass
(c) Energy (d) Both (a) and (b)

2. The birth and death rates of four countries are given below. Which one will have the least population growth rate?

Country	Birth rate/1000	Death rate / 1000
P	15	5
Q	25	10
R	35	18
S	48	41

(a) P (b) Q (c) R (d) S

3. Competition for light, nutrients and space is most severe between
(a) closely related organisms growing in different niches
(b) closely related organisms growing in the same area/niche
(c) distantly related organisms growing in the same habitat
(d) distantly related organisms growing in different niches.

4. 'Verhulst – Pearl' is associated with the equation
(a) $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$ (b) $\frac{dN}{dt} = tN\left(\frac{K-N}{N}\right)$
(c) $\frac{dN}{dt} = rN\left(\frac{K-N}{N}\right)$ (d) $\frac{dN}{dt} = tN\left(\frac{K-N}{K}\right)$.

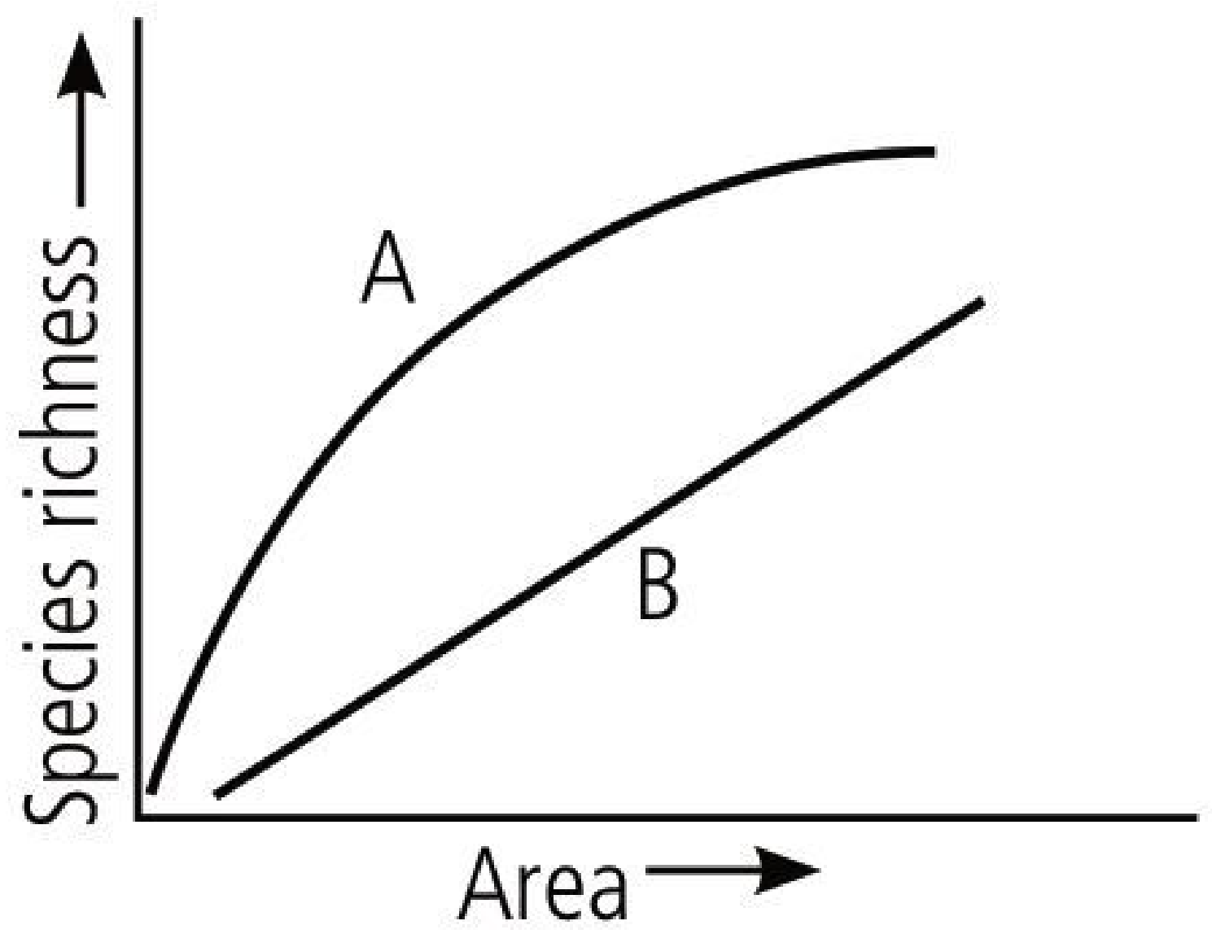
5. Hotspots are priority areas for *in situ* conservation. The key criteria for a determining a hotspot is/are
(a) number of species
(b) degree of endemism
(c) degree of threat to habitat due to degradation
(d) all of these.

6. Which one of these is not included in the biodiversity hotspots of India?
(a) Western Ghats (b) Himalayas
(c) Indo-Burma (d) North Indian Plains

7. In which of the following, both pairs have correct combination?

	In-situ conservation	*Ex-situ* conservation
(a)	Seed Bank	National Park
(b)	Tissue culture	Sacred groves
(c)	National Park	Botanical garden
(d)	Cryopreservation	Wildlife sanctuary

8. Which option correctly describes the equations for curves A and B, in the given graph of species - area relationship?



	A	B
(a)	$S = CA^Z$	$\text{Log } S = \text{Log } C + Z \text{ Log } A$
(b)	$\text{Log } S = \text{Log } C + Z \text{ Log } A$	$S = CA^Z$
(c)	$\text{Log } C = \text{Log } S + Z \text{ Log } A$	$S = CA^Z$
(d)	$S = CA^Z$	$\text{Log } C = \text{Log } S + Z \text{ Log } A$

9. Select the incorrect food chain.
(a) Grass → Grasshopper → Frog → Snake → Eagle
(b) Phytoplanktons → Zooplanktons → Small fish → Large fish
(c) Diatoms → Zooplanktons → Small fish
(d) Grass → Frog → Vulture

10. Connel's field experiment showed that on the rocky sea coasts of Scotland, larger barnacle *Balanus* dominates the intertidal area and removes the smaller barnacle *Chathamalus*. This happened due to
(a) parasitism (b) predation
(c) mutualism` (d) competition.

11. Select the option that correctly identifies A, B and C in the given table.

Organism	Trophic level	Food chain
Eagle	**A**	Grazing
Earthworm	Primary consumer	**B**
Frog	**C**	Grazing

	A	B	C
(a)	Top carnivore	Detritus	Secondary consumer
(b)	Top carnivore	Detritus	Primary consumer
(c)	Secondary consumer	Grazing	Secondary consumer
(d)	Scavanger	Grazing	Producer

12. Total number of individuals of a species per unit area and per unit time is called
(a) population size (b) population density
(c) demography (d) population dynamics.

Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R).

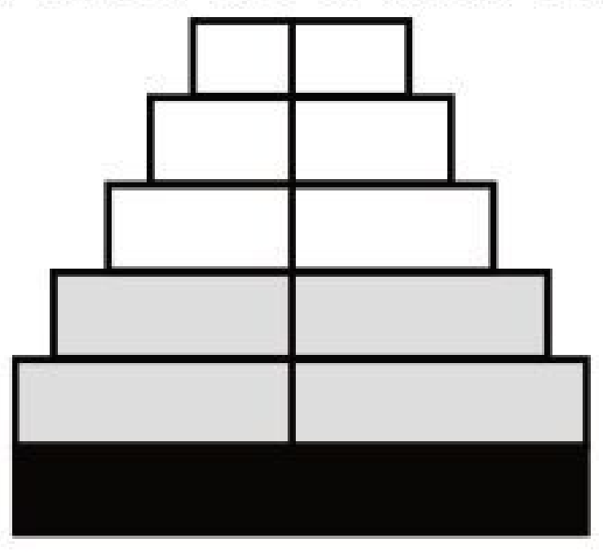
Answer these questions selecting the appropriate option given below:
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

13. Assertion : Plant-animal interactions involve co-evolution of the mutualist organisms.
Reason : Evolution of the flower and its pollinator species are tightly linked with one another.

14. Assertion : There are 34 biodiversity hotspots in the world.
Reason : High level of species richness is a criteria for selection of a biodiversity hotspot.

15. Assertion : Temperature and soil moisture are the important climatic factors that regulate the process of decomposition.
Reason : Warm and moist environment favours decomposition whereas low temperature and anaerobiosis inhibit decomposition.

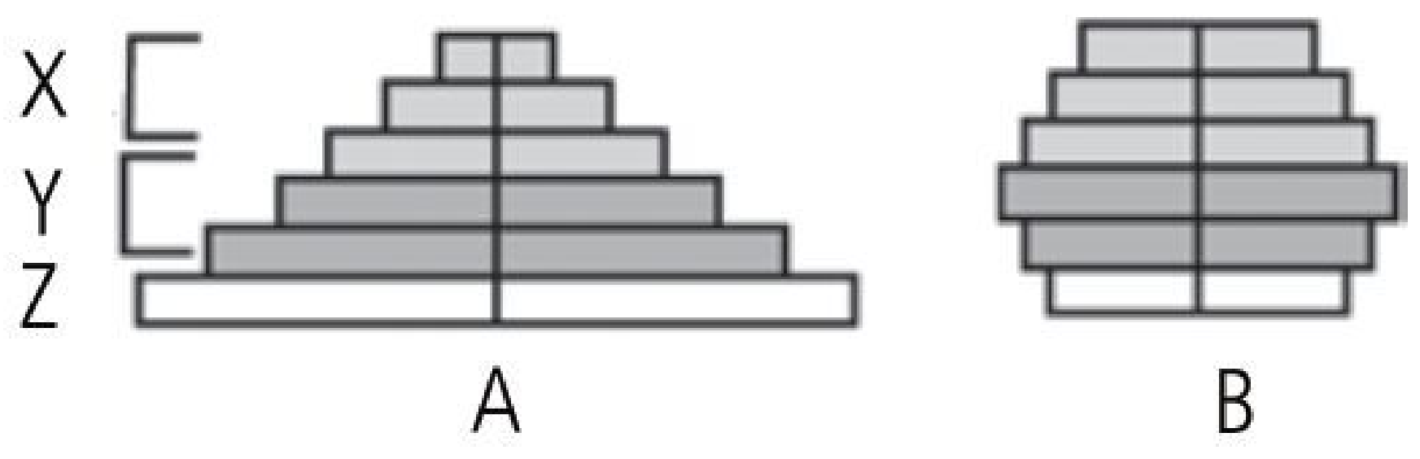
16. Age sex structure of a population can be depicted in the form of a pyramid by plotting the percentage of population of each sex in each age class. Study this pyramid and comment upon the appropriateness of the Assertion and the Reason.



Assertion : It is a bell-shaped age pyramid.
Reason : In a stable population, proportion of individuals in reproductive age group is higher than the individuals in pre-reproductive age group.

SECTION-B

17. The given figure shows the different types of age pyramids for human population.



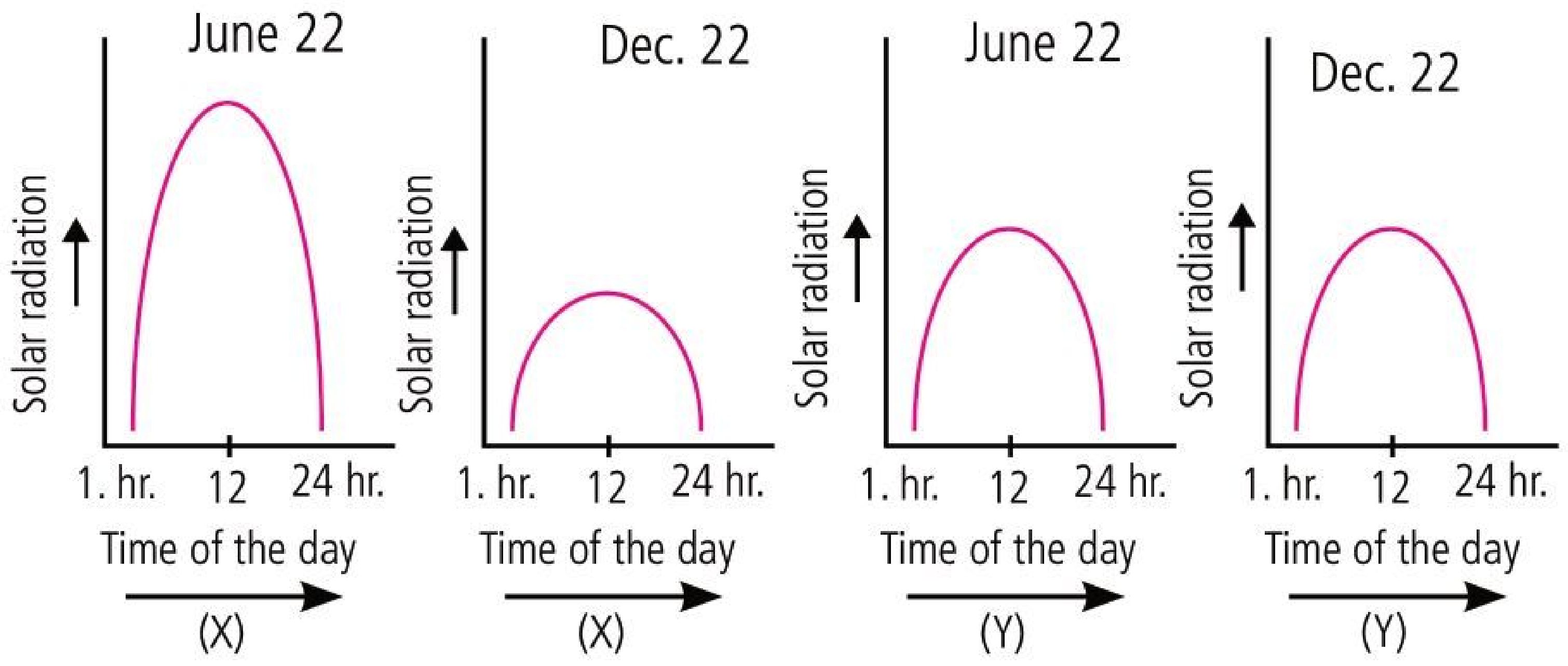
(a) What does the parts 'X', 'Y' and 'Z' represent?
(b) Which type of population is represented by pyramids A and B? Explain.

18. (a) Explain parasitism with the help of one example.
(b) State Gause's competitive exclusion principle.

19. Why is predation required in a community of different organisms?

20. (a) Draw a pyramid of numbers considering a big banyan tree supporting a population of insects, small birds and their predators.
(b) Construct an ideal pyramid of energy when 1,000,000 joules of sunlight is available. Label all its trophic levels.

21. The graphs (X) and (Y) below depict the diurnal variations in the solar radiations in the month of June (Summer) and in December (Winters):



(a) Which of the two graphs depicts tropical region and temperate regions respectively?

(b) Which of the two region (X) or (Y) will show high biological diversity and why?

OR

(a) Explain 'standing crop' in an ecosystem.

(b) Draw a pyramid of biomass when a small standing crop of phytoplanktons supports large standing crop of zooplanktons in the sea.

SECTION-C

22. Since the origin of life on earth, there were five episodes of mass extinction of species.

(a) How is the 'Sixth extinction', presently in progress, different from the previous episodes?

(b) Who is mainly responsible for the 'Sixth extinction'?

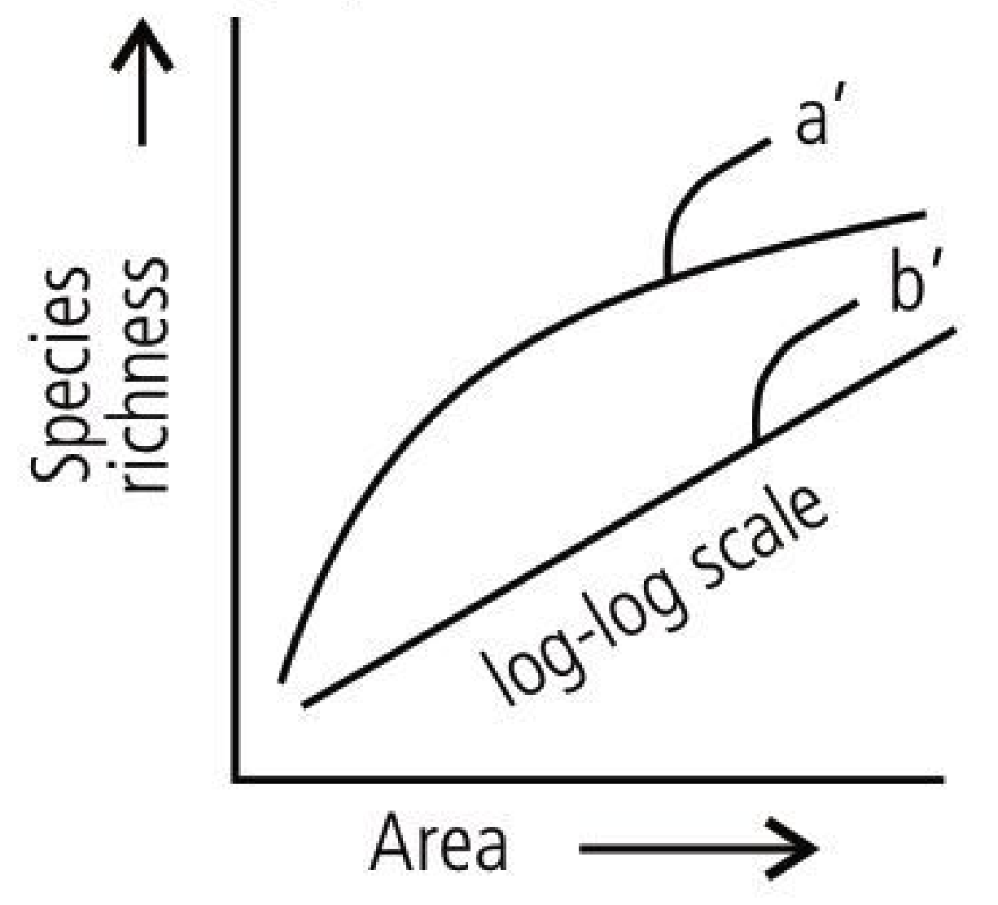
(c) List any four points that can help to overcome this disaster.

23. (a) Name the two growth models that represent population growth and draw the respective growth curves they represent.

(b) State the basis for the difference in the shape of these curves.

(c) Which one of the curves represent the human population growth at present? Do you think such a curve is sustainable? Give reason in support of your answer.

24. The given graph shows the species-area relationship. Answer the following questions as directed.



(a) Name the naturalist who studied the kind of relationship shown in the graph. Write the observation made by him.

(b) Write the situation as discovered by the ecologists when the value of 'Z' (slope of the line) lies between
(i) 0.1 and 0.2 (ii) 0.6 and 1.2.

(c) What does 'Z' stand for?

25. Several factors possess threats to indigenous species of a particular area. Introduction of alien species is one such threat. Justify it with few examples.

26. Name and describe any three causes of biodiversity losses.

OR

The population of a metro city experiences fluctuations in its population density over a period of time.

(a) When does the population in a metro city tend to increase?

(b) When does the population in a metro city tend to decline?

(c) If N is the population density at time 't', write the population density at time 't + 1'.

27. Study the table given below in regard to population interactions and answer the questions that follow:

Species A	Species B	Name of Interaction
–	0	(A)
+	–	(B)
–	–	(C)
+	+	(D)

[Note : (+) plus = beneficial interaction; (–) minus = detrimental interaction; (0) zero = neutral interaction]

(a) Identify the interactions (A) to (D).

(b) Explain interaction (A).

28. There are many animals that have become extinct in the wild but continue to be maintained in Zoological parks.

(a) What type of biodiversity conservation is observed in this case?

(b) Explain any other two ways which help in this type of conservation.

SECTION-D

Question No. 29 and 30 are case based questions. Each question has subparts with internal choice in one subpart.

29. Population interaction is the interaction between different populations. There is no natural habitat on earth *i.e.*, inhabited by single species.

Refer to the given table that represents the interaction between organism 1 and organism 2.

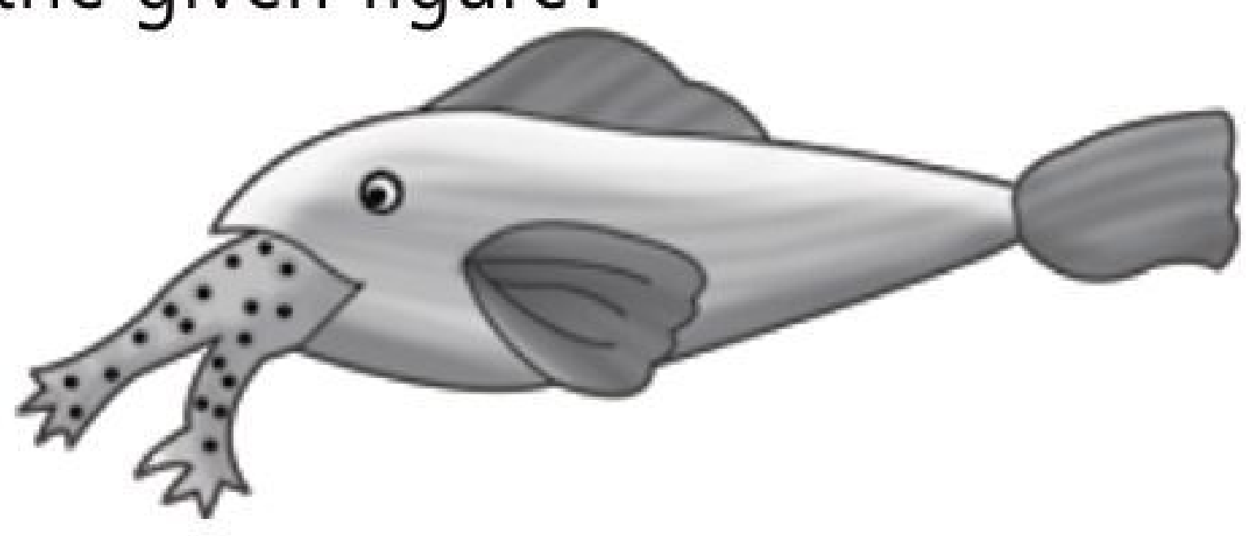
Motivational Quote

> An investment in knowledge always pays the best interest.
>
> **– *Benjamin Franklin***

Effect on organism 1		Effect on Organism 2		
		Benefit	Harm	No Effect
	Benefit	**A**	**B**	Commensalism
	Harm	Parasitism	Competition	Amensalism
	No effect	**C**	Amensalism	—

(a) Identify the types of interaction A, B and C.

(b) Which type of interaction from the above table is being shown in the given figure?



(c) Define 'C' with the help of the examples.

OR

(c) Explain how mycorrhizae shows A type of interaction.

30. An ecology student was studying about pyramid of biomass which is a graphic representation of biomass (total amount of living or organic matter in an ecosystem at any time) per unit area in different trophic levels. He was provided with an assessment by his teacher to analyse pyramid of biomass for two cases.

In case I, a food chain include grasses (70% population of entire ecosystem), rabbit, rats and mice (50%), snakes, lizards (30%) and birds (10%).

In case II, a food chain includes diatoms (20%), zooplankton (40%), small fishes (60%) and large fishes (80%).

(a) In which of the following cases gross primary productivity (GPP) would be maximum?

(b) Which of the following from case I represent same trophic level as that of zooplankton of case II?

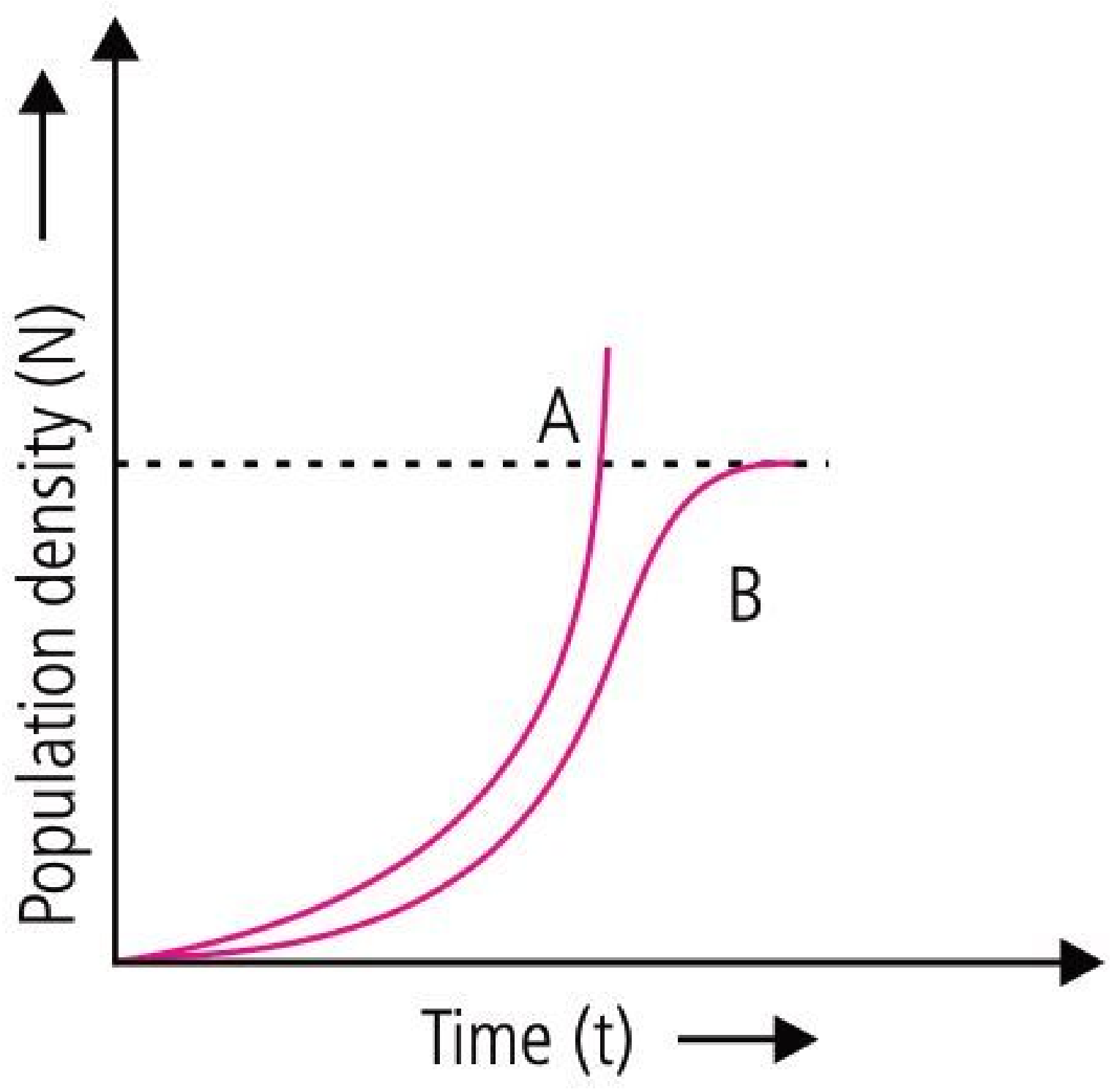
(c) Draw the pyramid of biomass of case I and II based on the given data.

OR

(c) 4g/m^3 of biomass is available at diatom level in case II. What is expected biomass concentration at small fish level?

SECTION-E

31. Study the graph given below and answer the questions that follow.



(a) Write the status of food and space in the curves A and B.

(b) In the absence of predators, which one of the two curves would appropriately depict the prey population?

(c) Time has been shown on X-axis and there is a parallel dotted line above it. Give the significance of this dotted line.

OR

(a) Explain the narrowly utilitarian, broadly utilitarian and ethical arguments in favour of conservation of biodiversity.

(b) How is designation of certain areas as hotspots a step towards biodiversity conservation? Name any two hotspots in India.

32. **(a)** Draw a 'pyramid of numbers' of a situation where a large population of insects feed upon a very big tree, the insects in turn, are eaten by small birds which in turn are fed upon by big birds.

(b) Differentiate giving reason, between the pyramid of biomass of the above situation and the pyramid of numbers that you have drawn.

OR

"It is often said that the pyramid of energy is always upright. On the other hand, the pyramid of biomass can be both upright and inverted." Explain with the help of examples and sketches.

33. **(a)** What is "population" according to you as a biology student?

(b) "The size of a population for any species is not a static parameter". Justify the statement with specific reference to fluctuations in the population density of a region in a given period of time.

OR

Given below is a table depicting population interactions between species A and species B.

Type of interaction	Species A	Species B
(P)	(–)	(–)
(Q)	(+)	(–)

(a) Name the types of interactions (P) and (Q) in the above table.

(b) Justify giving three reason, how the type of interaction (Q) is important in an ecological context.

SOLUTIONS

1. **(c) :** Pyramid of energy is always upright, can never be inverted, because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step.

2. **(d) :** Growth rate = Birth rate – Death rate
For country P, it is 10/1000. For country Q, it is 15/1000.
For country R, it is 17/1000 and for country S, it is 7/1000.
Hence, country S has the least population growth rate.

3. **(b)**

4. **(a) :** The logistic growth show sigmoid curve and is also called Verhulst-Pearl logistic growth. This is described by the following equation:

$$dN/dt = rN\left(\frac{K-N}{K}\right)$$

where, *N* is population density at time *t*, *K* is carrying capacity and *r* is intrinsic rate of natural increase.

5. **(d) :** 'Hotspot' is a term used to define regions of high conservation priority combining high richness, high endemism and high threat.

6. **(d)** 7. **(c)** 8. **(a)**

9. **(d) :** Frog is the secondary consumer, *i.e.*, it feeds upon herbivore in a particular food chain but in the given food chain (option d) it is acting as a primary consumer hence, the given food chain is incorrect.

10. **(d) :** Competition is a rivalry between two or more organisms for obtaining the same resources.

11. **(a)**

12. **(b) :** Population density is the number of individuals present per unit area or volume at a given time.

13. **(a)** 14. **(b)** 15. **(b)**

16. **(c) :** In a bell-shaped age pyramid, the number of pre-reproductive and reproductive individuals is almost equal. Post-reproductive individuals are comparatively fewer. It represents a stable population.

17. **(a)** X, Y and Z represent different age groups (male and female) found in a population. Here, X is post-reproductive, Y is reproductive group and Z is pre-reproductive group.

(b) Pyramid A is triangular age pyramid which represents expanding population. Here, number of pre-reproductive individuals is very large, number of reproductive individuals is moderate and post-reproductive individuals are fewer.

Pyramid B is urn-shaped age pyramid representing declining population with higher proportion of reproductive age group than pre and post-reproductive age group.

18. **(a)** Parasitism is the interspecific interaction where one of species (called parasite) depends on the other species (host) for food and shelter and damages the host. *E.g.*, malarial parasite in blood cells of humans.

(b) Gause's competitive exclusion principle states that two or more species with similar niche requirements cannot coexist indefinitely in the same area and competitively inferior one gets eliminated.

19. Predators plays an important role in a community :

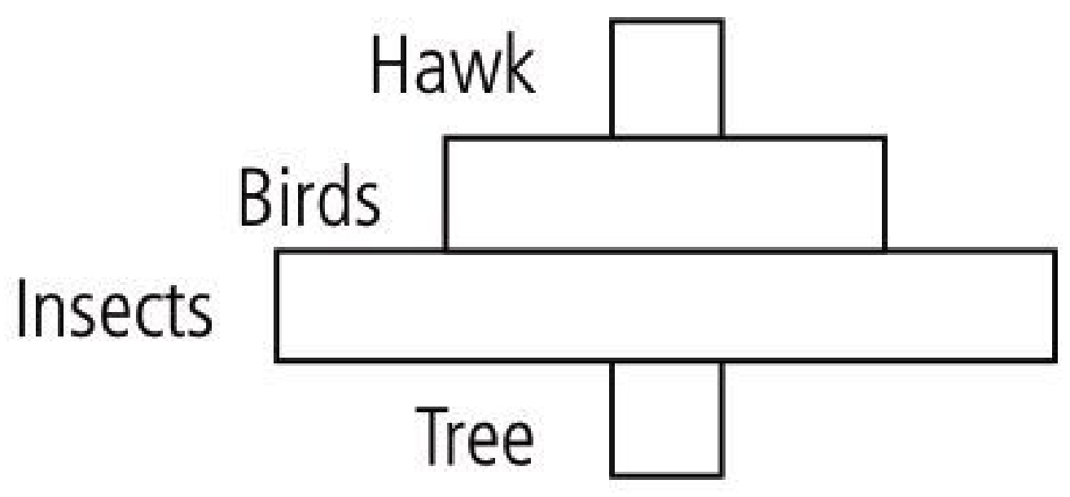
(i) They act as conduits for energy transfer across trophic levels.

(ii) Predators keep prey population under control. They are used for biological control of weeds and pests.

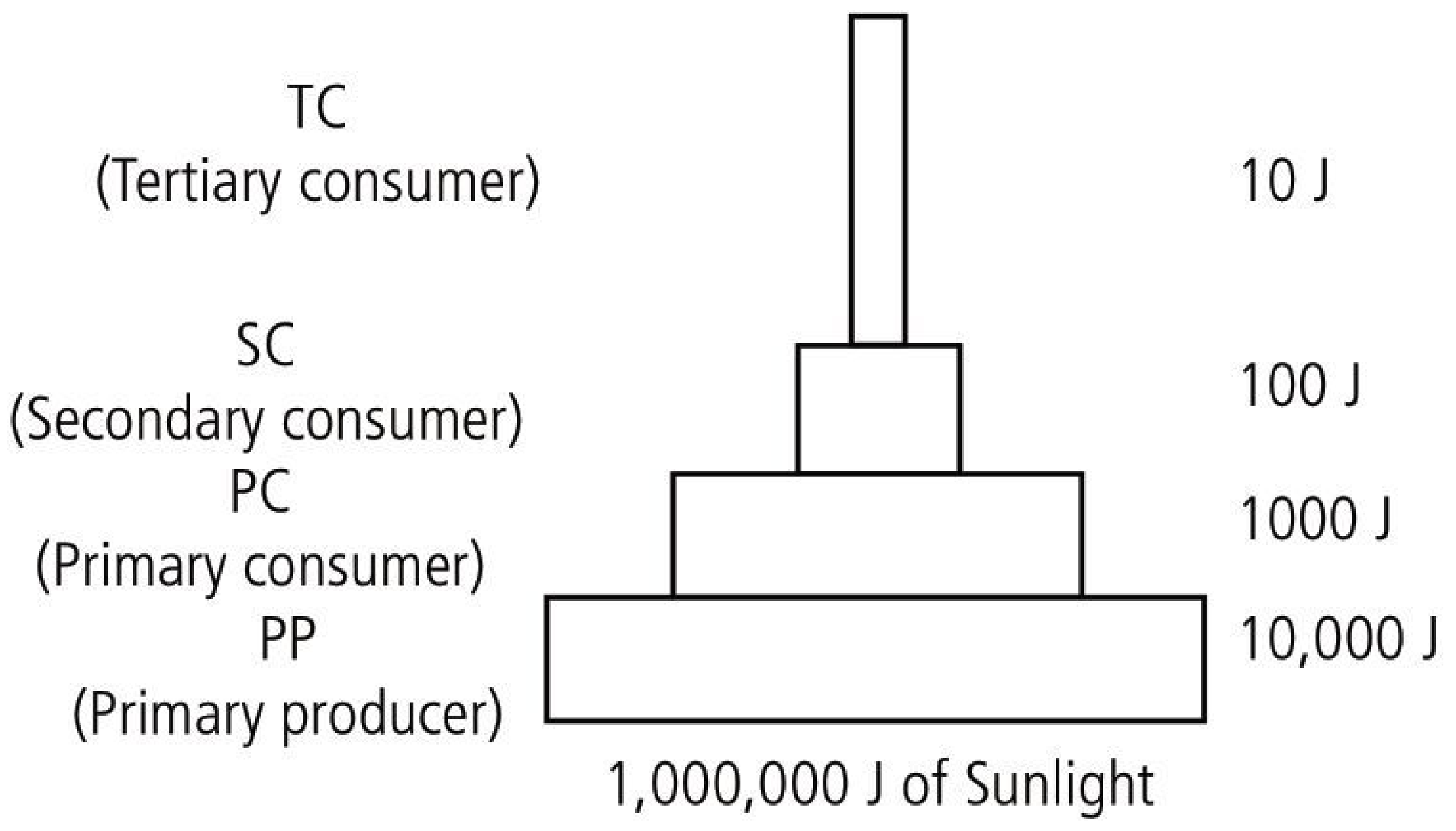
(iii) Predators help in maintaining species diversity.

(iv) They help in growth of vegetation by controlling population of herbivores.

20. (a) The pyramid of numbers considering a big banyan tree supporting a population of insects, small birds and their predators will be spindle–shaped as shown :



(b) An ideal pyramid of energy with primary producers storing only 1% of solar energy as net primary productivity (NPP) is shown below:



21. **(a)** Graphs which represent tropical region are:

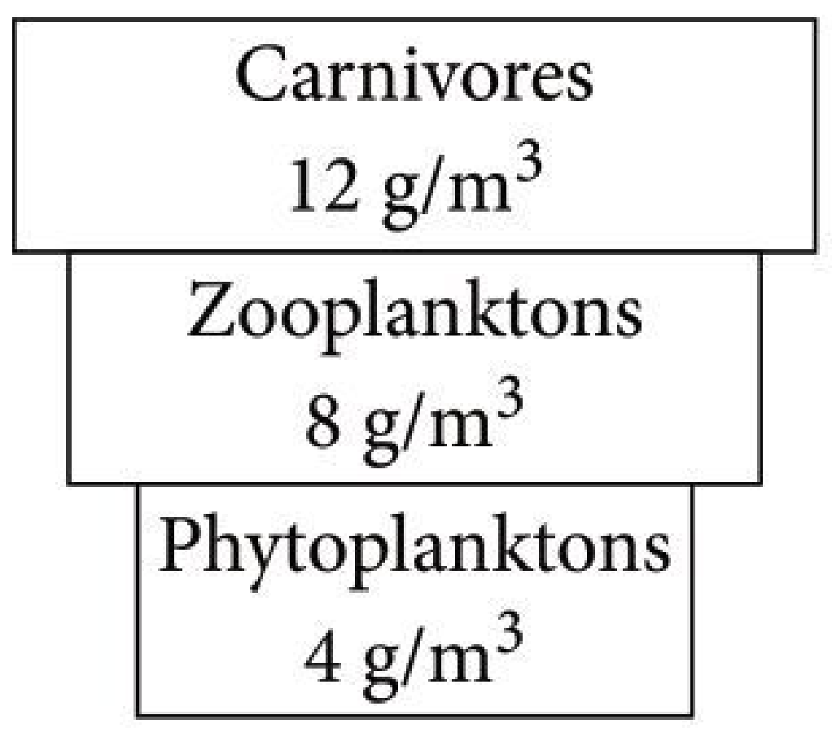
- Dec 22 → X
- June 22 → Y

The temperate regions are depicted by graphs:

- June 22 → X
- Dec 22 → Y

(b) The tropical region will show high biological diversity. This is because it produces more solar radiations than temperate zones, and they have a stable climate and few seasonal changes. This encourages more productivity and hence more species richness, leading to higher biological diversity.

OR



(a) Standing crop refers to mass of living material at a particular trophic level at a particular time. It is measured as biomass or the number in a unit area.

(b) Pyramid of biomass in sea is inverted as shown above:

22. **(a)** Sixth extinction, *i.e.*, the current species extinction is 100 – 1000 times faster than extinctions in pre-human times.

(b) Human activities like settlements, hunting, over exploitation and habitat destruction are mainly responsible for 'Sixth extinction'.

(c) This disaster can be overcome by the following ways:

(i) Planting large number of trees on road sides and where space is available.

(ii) Avoid introduction of invasive alien species.

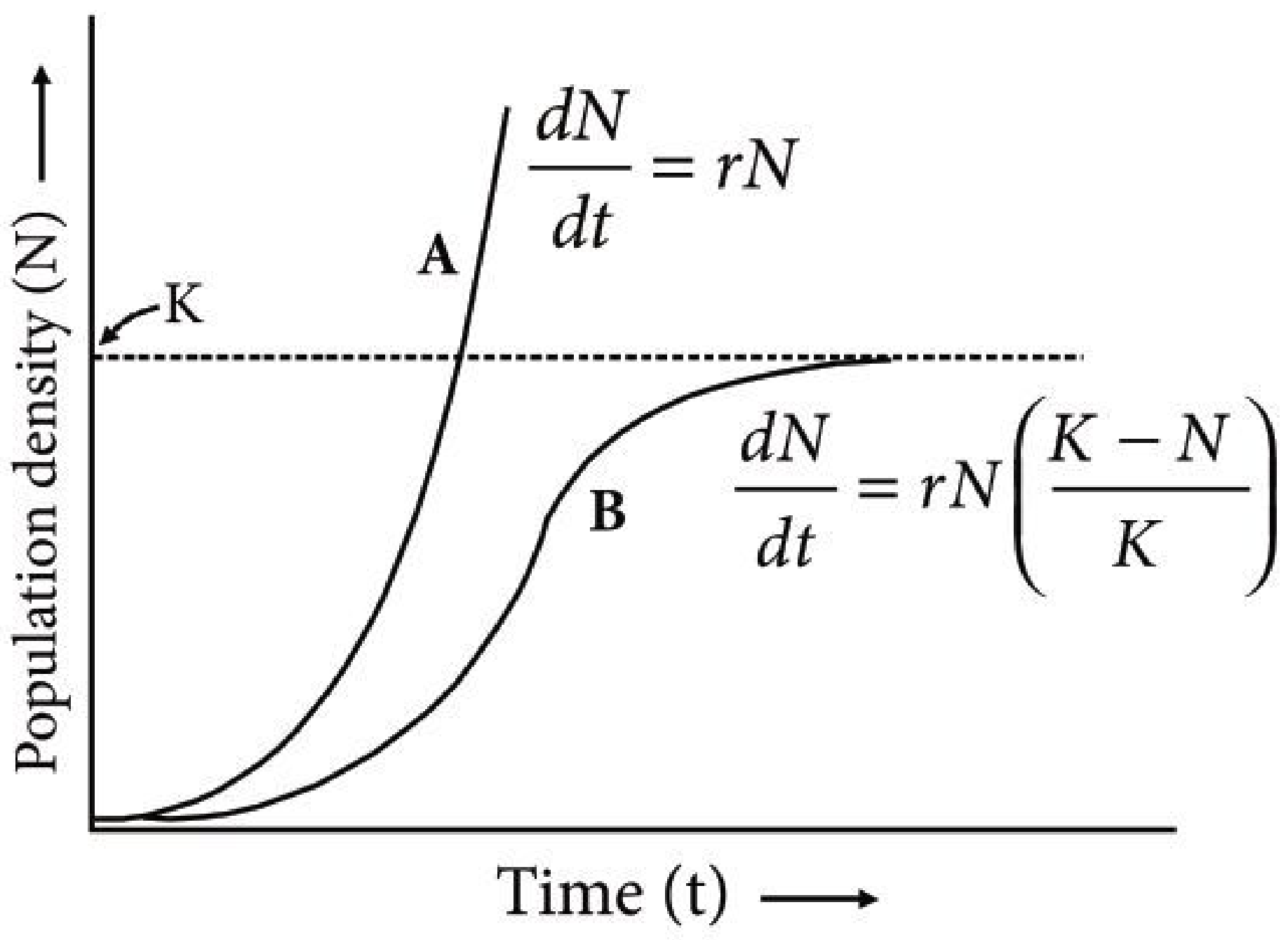
(iii) Conserving biodiversity by maintaining National parks, zoos, etc.

(iv) Deforestation and fragmentation of forested areas should be stopped.

23. (a) Two growth models of population growth are as follows :

(i) A : J-shaped curve showing exponential growth

(ii) B : S-shaped curve showing logistic growth



(b) Difference in shape of curves is due to difference in amount of resources available.

(c) Human population growth represents logistic growth form. This curve is sustainable as resources are limited and environment cannot support population beyond carrying capacity.

24. (a) Alexander von Humboldt studied species-area relationship. He observed that within a region, the species richness increases with increasing area but upto a certain limit.

(b) (i) Ecologists have discovered that the value of Z lies in the range of 0.1–0.2 regardless of taxonomic group or region, *i.e.,* whether it is plants in Britain, birds in California or molluscs in New York, the slopes of the regression line are similar.

(ii) When the species-area relationship is considered for a very large area like a whole continent, regression coefficient Z or slope of the line become steeper with Z values in the range of 0.6 –1.2.

(c) *Z* stands for regression coefficient.

25. Non-native or alien species are often introduced inadvertently by man for their economic and other uses. They often become invasive and drive away the local species. For example:

(i) Water hyacinth (*Eichhornia crassipes*) was introduced in Indian waters to reduce pollution but it turned out to be a problematic species. It has clogged water bodies including wetlands at many places resulting in death of several aquatic plants and animals.

(ii) Nile Perch (a predator fish) was introduced in lake Victoria of South Africa. It killed and eliminated ecologically unique assemblage of over 200 native species of small cichlid fish.

(iii) African catfish *Clarias gariepinus* introduced for aquaculture in India pose threat to indigenous catfishes.

26. The three major causes of biodiversity loss are :

(i) Habitat loss and fragmentation - Over-population, urbanisation and industrialisation require additional land every year. It can come through destruction or fragmentation of natural habitats. Loss of habitat results in annihilation of species of endemic plants, microorganisms and forcing out of animals which in alien lands die out after some time.

(ii) Over-exploitation – Excessive exploitation of a species, whether a plant or an animal, reduces size of its population so that it becomes vulnerable to extinction. Due to over-exploitation by humans, Dodo, three subspecies of tiger and Steller's sea cow have become extinct in the last 500 years.

(iii) Co-extinction – When a species become extinct, the plant and animal species associated with it in an obligatory way also become extinct. Another example is the case of a coevolved plant pollinator mutualism where extinction of one invariably leads to the extinction of the other.

OR

(a) Population of a metro city tends to increase when natality rate exceeds mortality rate due to better health services and also due to lack of unplanned population control measures. Also when immigration exceeds emigration, population of a city tends to increase.

(b) Population of a metro city tends to decline when mortality rate is higher than natality rate and emigration exceeds immigration.

(c) If N is the population density of time t, then its density at time t + 1 will be

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

Where B = No. of Births, I = Immigration
D = No. of Deaths, E = Emigration

27. (a) (A) = Amensalism (B) = Parasitism/Predation
(C) = Competition (D) = Mutualism

(b) Amensalism (interaction A) is an association between organisms of different species that is detrimental to one of the species but has no effect on the other. A common example of amensalism is the release of chemical toxins by plants that can inhibit the growth of the other plant species (allelopathy).

28. **(a)** Zoological parks represent ***ex-situ*** conservation.

(b) ***Ex-situ*** conservation is conservation of endangered plants and animals outside their natural homes. It includes tissue culture and cryopreservation. Tissue culture is carried out through callus formation, embryoids, pollen grain culture and shoot tip culture for those plants which are either seedless, variable seed progeny or where clone is to be maintained. The method is useful in maintaining a large number of genotypes in small area, rapid multiplication of even endangered species and for hybrid rescue.

Cryopreservation is an ***ex-situ*** conservation technique in which tissues, organs, embryos, seeds, etc. are stored at very low temperature of −196°C. At this temperature the living material can be stored indefinitely in compact, low maintenance refrigeration units. It can be revived through special technique when required. In order to prevent extinction, endangered organisms are being cryopreserved so that they can be revived to help in conservation.

29. **(a)** A-Mutualism, B-Predation or parasitism, C-Commensalism.

(b) Predation (B) is an interaction between members of two species in which members of one species capture, kill and eat up members of other species. The former are called predators and the latter are called preys.

(c) Commensalism *i.e*, 'C' is an interaction between two individuals where one is benefited while the other is neither benefited nor harmed. Two examples:

- Barnacle growing on the back of a whale.
- Cattle egrets foraging close to the grazing cattle.

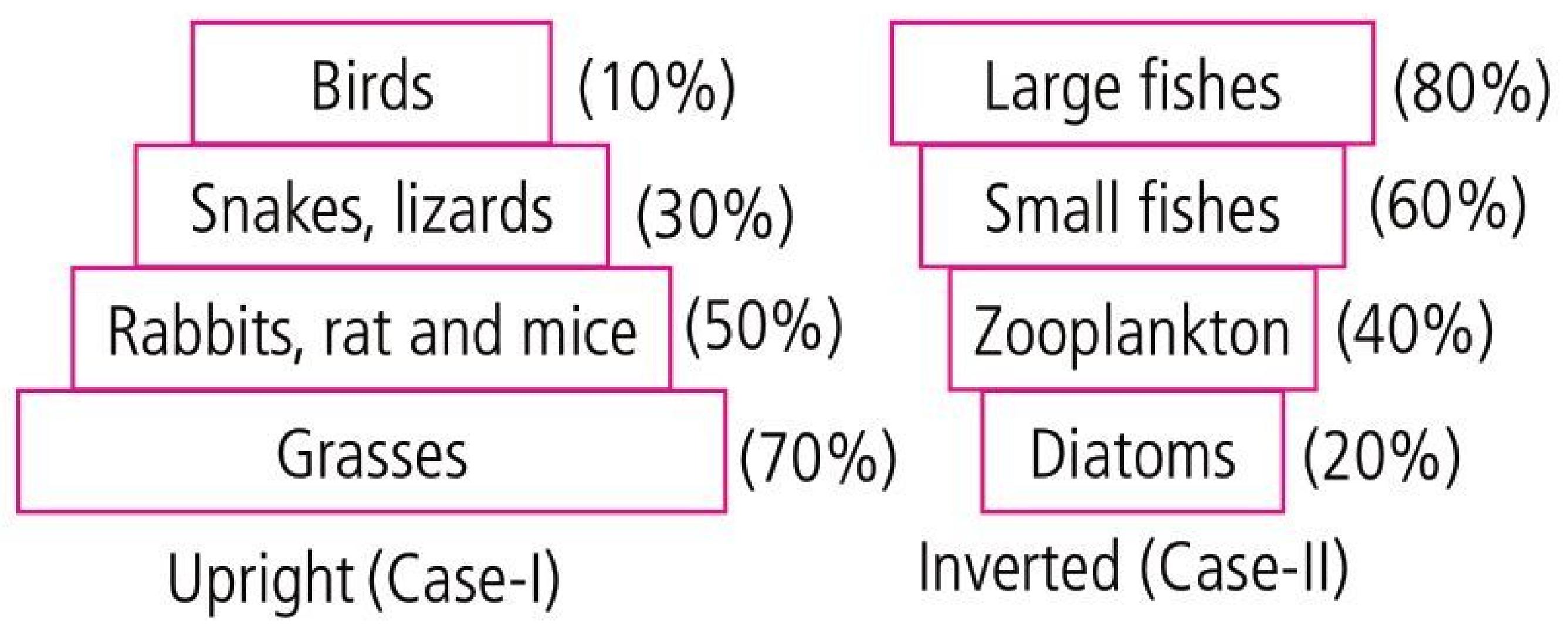
OR

(c) Mycorrhizae are associations between fungi and the roots of higher plants. The fungi help the plant in the absorption of essential nutrients from the soil while the plant in turn provides the fungi with energy-yielding carbohydrates.

30. **(a)** In case I only, GPP would be maximum because the number of producers are more than in case II.

(b) Zooplanktons are primary consumers (herbivores) in aquatic ecosystem they can be replaced by rabbits, rats and mice which are also primary consumers (herbivores) in terrestrial ecosystem.

(c)



Upright (Case-I) Inverted (Case-II)

OR

(c) The biomass concentration will increase from lower to higher trophic level in case II.
If biomass of 20% diatoms = 4 g/m^3.
then biomass of 60% small fishers = 4 × 60/20
= 4 × 3 = 12 g/m^3.
Therefore, the concentration available at small fishes level would be 12g/m^3.

31. **(a)** There is ample food and space for the population depicted by the curve A. When the resources are unlimited, the curve is exponential. There is limited food and space for the population depicted by the curve B. When the resources are limiting, the curve becomes sigmoid.

(b) In the absence of predators, curve B would appropriately depict the prey population.

(c) The dotted line represents the carrying capacity of the environment. The carrying capacity represents (*i.e.*, represented by '*K*') the size of population that the environment can hold by providing necessary resources. When a population reaches this line its population size is stabilised by various environmental factors.

OR

(a) The reasons for conserving biodiversity can be grouped into three categories:

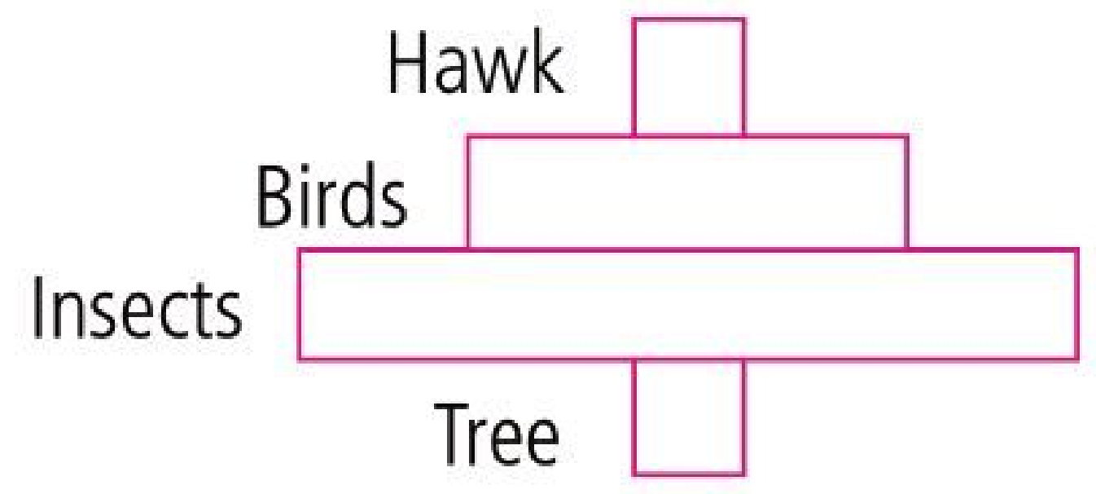
(i) The narrowly utilitarian argument says that humans derive many economic benefits from nature such as food, firewood, construction material, industrial products, medicines, etc. This can be done by 'bioprospecting' (exploring molecular, genetic and species-level diversity for products of economic importance).

(ii) The broadly utilitarian argument says that biodiversity plays a major role in many ecosystem services that nature provides. *e.g.* : The Amazon forest produces 20% of the total oxygen in the earth's atmosphere.

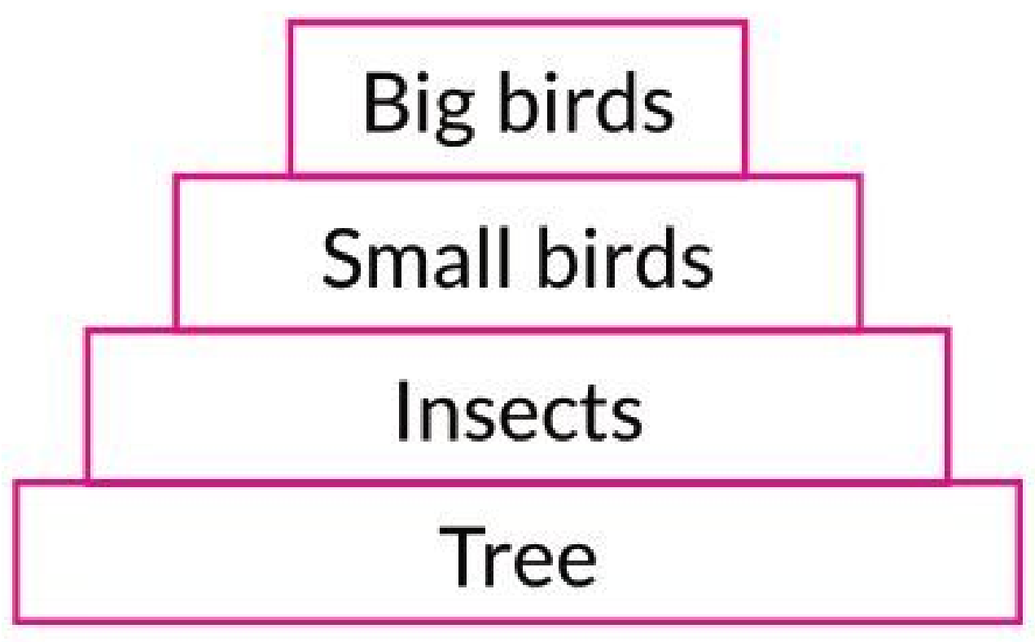
(iii) The ethical argument says that we owe it to the millions of species with whom we share this planet to conserve biodiversity.

(b) 'Biodiversity hotspots' are the regions of very high levels of species richness and high degree of endemism. It is important to provitise conservation spending. Hence, designation of certain areas as hotspots is a step towards biodiversity conservation. Himalayas and Western Ghats are two hotspots in India.

32. **(a)** In the given case, pyramid of numbers will be spindle-shaped as shown here :



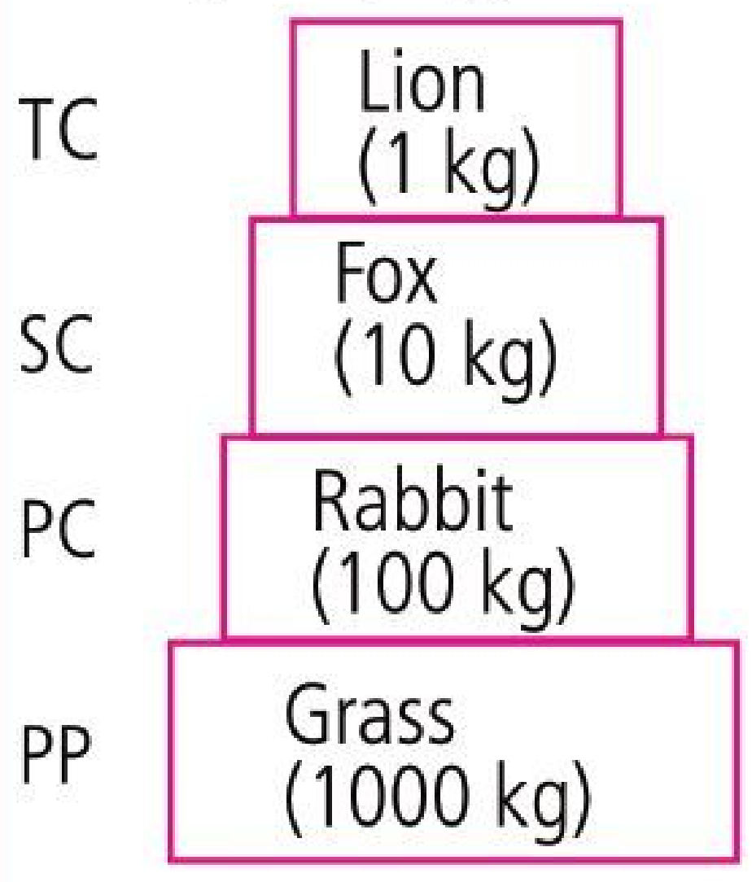
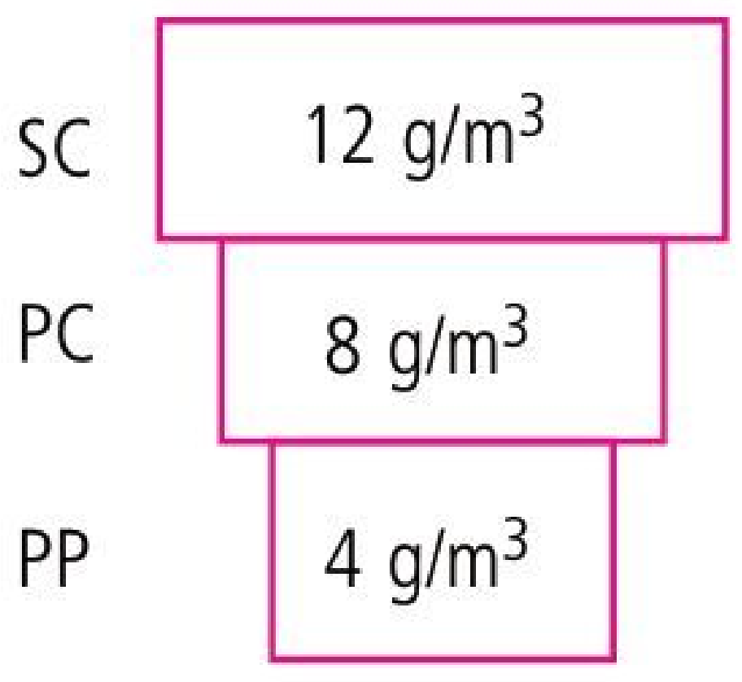
(b) Pyramid of biomass in the above situation will be upright as tree has the maximum biomass which reduces with successive trophic levels resulting in an upright pyramid whereas the pyramid of number in above case is spindle-shaped where producers which are mainly large sized trees are lesser in number and form the base of the pyramid. The insects are more in number than producers. Then, there is gradual decrease in the number of successive carnivores, thus making the pyramid upright again. The pyramid of biomass for the above situation is given as follows:



OR

The pyramid of energy is always upright in shape as there is always a gradual decrease in the energy content at successive trophic levels from producers to various consumers. This is because some energy is used at each trophic level for various metabolic activities and some energy is lost as heat, so only 10% of the energy is available to the next trophic level (Lindeman's 10% law).

Pyramid of biomass is a graphic representation of biomass present sequence-wise per unit area of different trophic levels with producers at the base and top carnivores at the apex. Pyramid of biomass may be upright or inverted.

	Upright pyramid of biomass	**Inverted pyramid of biomass**
(i)	The biomass of producers is more than that of consumers.	The biomass of producers is less than that of consumers.
(ii)	Pyramid of biomass in grassland ecosystem is always upright.  TC Lion (1 kg) SC Fox (10 kg) PC Rabbit (100 kg) PP Grass (1000 kg) **Fig:** Upright pyramid of biomass	Pyramid of biomass in aquatic ecosystem is always inverted.  **Fig :** Inverted pyramid of biomass

33. (a) According to me as a biology student, population is defined as the total number of interbreeding individuals of a species found in a geographical area who share and compete for similar resources.

(b) The population density is the number of individuals of a species per unit area/space at a given time. The size of a population (population density) is not a static parameter. It keeps changing with time, depending upon a number of factors :abiotic and biotic, food availability, predation pressure, etc. The density of a population changes due to four basic processes:

(i) Natality : Number of births during a given period per unit population.

(ii) Mortality : Number of deaths in the population during a given period.

(iii) Immigration : Number of individuals of the same species moving inside a population during the time period.

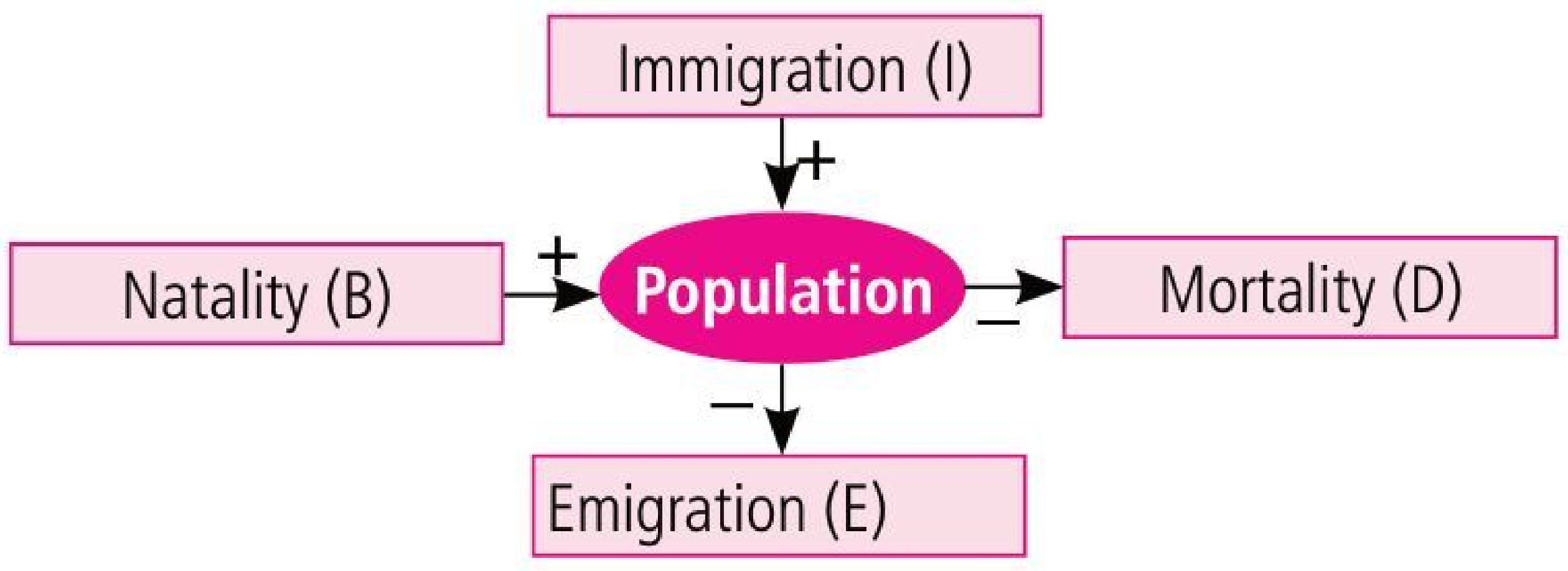
(iv) Emigration : Number of individuals moving outside from a habitat during the time period.

Therefore, if N is the population density at time t, then its density at time t + 1 can be explained by the given equation :

$$N_{t+1} = N_t + [(B+I) - (D+E)]$$

where B represents natality or number of births;
I represents number of immigrants;
D represents mortality or number of deaths;
E represents number of emigrants.

From this equation, it is clear that population density increases if the number of births plus the number of immigrants (B + I) is more than the number of deaths plus the number of emigrants (D + E). Otherwise it will decrease.



OR

(a) P is competition whereas Q could be predation or parasitism

(b) Importance of predation in ecological context are as follows:

- Nature's way of transferring energy fixed by plants to higher trophic levels and conduits for energy transfer.
- Keep prey population under control.
- Predators help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.

* * *

WHO AM I ...

1.	Carotene	Pg. 37
2.	Cytochrome c oxidase	Pg. 39
3.	Auxin	Pg. 44
4.	Gel electrophoresis	Pg. 71
5.	Biopatent	Pg. 75

Be Lab READY!

Class XII

Experiment-1

AIM

- To study and identify the stages of gamete development in mammals (mice), *i.e.*, T.S. of testis and ovary through permanent slides (spotting).

REQUIREMENTS

- Permanent slides of T.S. of testis and ovary, compound microscope, lens-cleaning paper and cleaning fluid.

THEORY

- In all male and female organisms, gamete formation takes place in their gonads, *i.e.,* testis and ovary respectively. The process of gamete formation, called gametogenesis involves meiotic cell division. The gametogenic development in testis is called spermatogenesis and in ovary, it is oogenesis. They exhibit marked differences and can be examined in transverse section (T.S.) of these organs.

Testis

- It is the male reproductive organ of animals which produce sperms by the process of spermatogenesis. Process of spermatogenesis includes:
  - (a) **Multiplication Phase :** The spermatogonia or sperm mother cells are formed from primary germ cells and these increase in number by mitosis and then grow into primary spermatocytes.
  - (b) **Maturation phase :** Primary spermatocytes undergo meiotic division; meiosis I gives rise to secondary spermatocytes which undergo meiosis II to form spermatids.
  - (c) **Spermiogenesis :** Transformation of spermatids into spermatozoa is called spermiogenesis. Sperms are formed in seminiferous tubules of testis. Seminiferous tubules also contain elongated sertoli cells which provide nutrition to the developing sperms. Interstitial cells in the connective tissue between seminiferous tubules secrete testosterone.

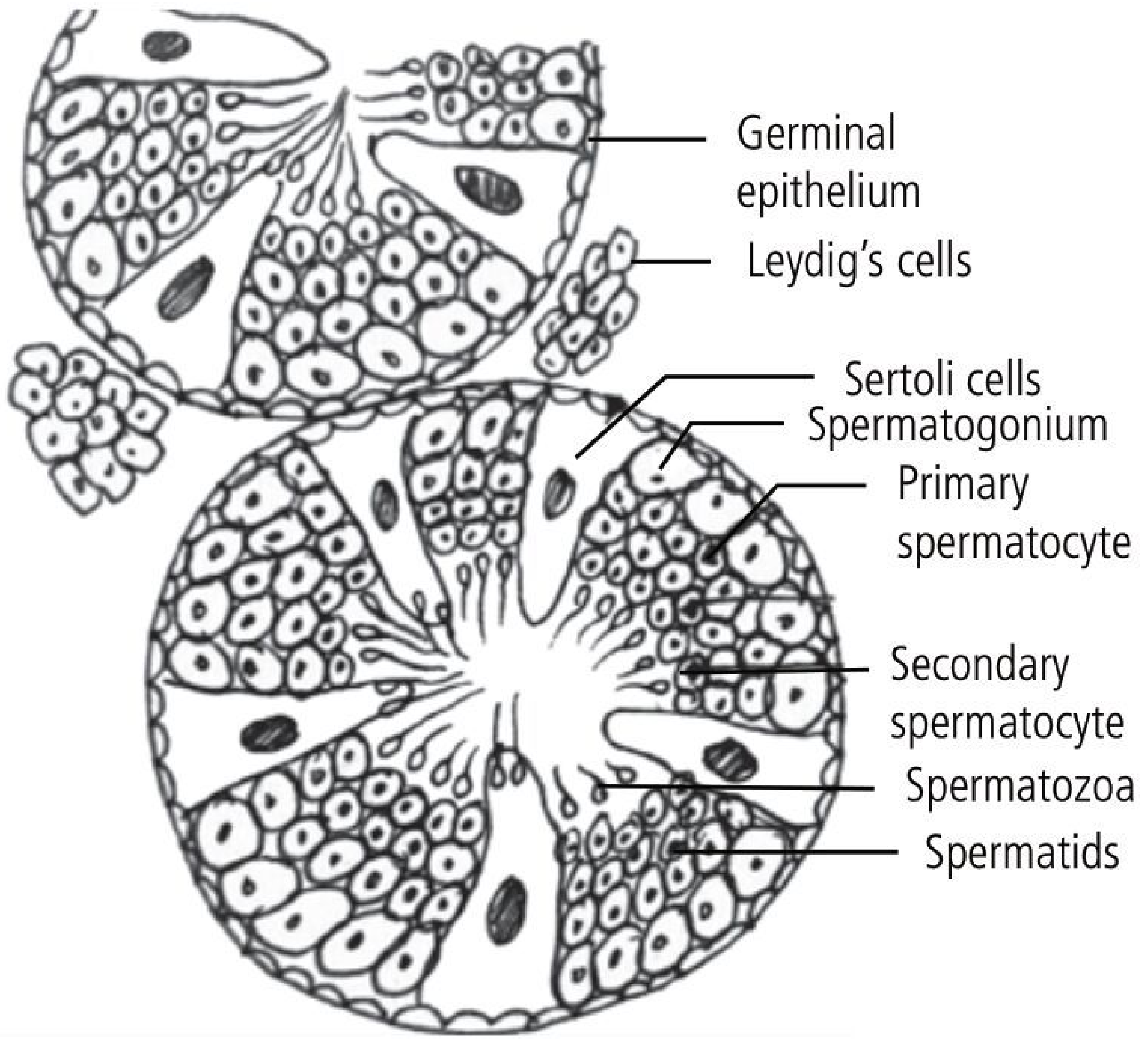


Fig.: T.S. of testis

Ovary

- Primary sex organ in females, is the site of ovum development by the process of oogenesis. Process of oogenesis includes:
  - (a) **Multiplication phase :** In the fetal development, certain cells in the germinal epithelium of the ovary of fetus are larger than others. These cells divide by mitosis and produce a couple of million oogonia. The oogonia multiply by mitotic divisions forming primary oocytes.

(b) **Growth phase :** Each primary oocyte is surrounded by a layer of granulosa cells called primary follicles.

(c) **Maturation phase :** Primary oocyte undergoes meiosis I to form secondary oocyte and a polar body which further undergo meiosis II to form ovum and second polar body. The polar bodies disintegrate due to lack of cytoplasm and food. Unequal cytoplasmic division enables the ovum to retain whole cytoplasm of primary oocyte in it, for the development of future embryo. In humans, ova is released from ovary at secondary oocyte state and maturation is completed in the female genital tract, usually after receiving the sperm. After ovulation, secondary oocyte is carried down to fallopian tube but meiosis II is resumed after metaphase II only, when sperm enters in the secondary oocyte. The follicular cells, which are left behind in the ovary constitute corpus luteum which secrete progesterone.

PROCEDURE

- (i) Clean the slide and microscope's eye and objective lenses with the help of lens cleaning paper using any cleaning fluid. (ii) Place the slide on the stage of the microscope and observe first under lower magnification and then in higher magnification. Observe various stages of gamete development. (iii) Record your observations in the notebook and draw labelled diagrams.

OBSERVATIONS

T.S. of mammalian testis shows

(i) Testis is covered by thick fibrous tissue called tunica albuginea,

(ii) It contains many seminiferous tubules embedded in interstitial tissue.

(iii) Various germinal cells are seen in seminiferous tubules in the following order from periphery towards lumen in different layers:

$$\underset{(2n)}{\text{Spermatogonia}} \rightarrow \underset{(2n)}{\text{Primary spermatocytes}} \xrightarrow{\text{Meiosis-I}} \underset{(n)}{\text{Secondary spermatocytes}} \xrightarrow{\text{Meiosis-II}} \underset{(n)}{\text{Spermatid}} \xrightarrow{\text{Differentiation}} \underset{(n)}{\text{Spermatozoa}}$$

T.S. of mammalian ovary shows

(i) In the section of ovary, there is a mass of tissue lined with germinal epithelium, inside of that you will observe an ovum, which is a cell surrounded by one to several layers of follicular cells. As the ovum matures, the number of surrounding follicular cell layer increases.

(ii) In the later stage of follicular development a cavity called antrum appears.

(iii) The cavity gets further enlarged and the follicle grows bigger. This is the stage of Graafian follicle ready to release the ovum (ovulation).

(iv) In the next stage, you may notice a corpus luteum, and/or Corpus albicans, which differ from each other and also from Graafian follicle in their features.

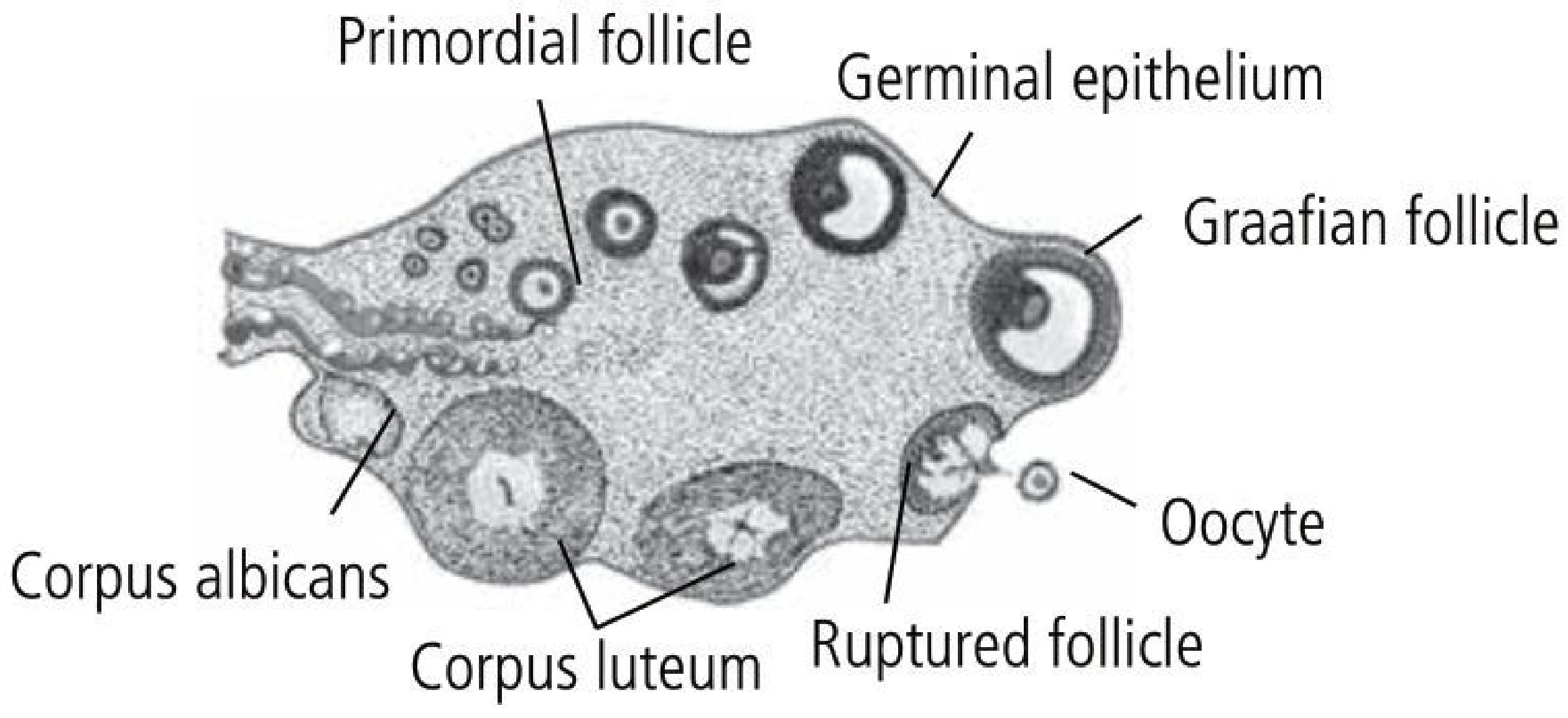


Fig.: T.S of ovary

DISCUSSION

- Spermatogenesis is a continuous process after attainment of puberty, and that is why gamete development and spermatozoa are observed in a single seminiferous tubule. In case of ovary, the follicular development stages are observed.

VIVA-VOCE

1. Can we see all the stages of oogenesis at a time in ovary?

Ans. No, we cannot see all the stages of oogenesis at a same time in ovary but different stages can be seen when ovary is observed for entire period of menstrual cycle.

2. Why ova are formed in less number as compared to sperms?

Ans. Sperms are formed in large numbers to ensure fertilisation whereas ova are produced in less numbers and only one at a time for the convenience and the ability of the mother to bear the foetus.

3. Name the hormones secreted by corpus luteum and Leydig cells.

Ans. Corpus luteum secretes progesterone whereas Leydig cells secrete testosterone.

4. At what stage does the human ovum is released from the ovary?

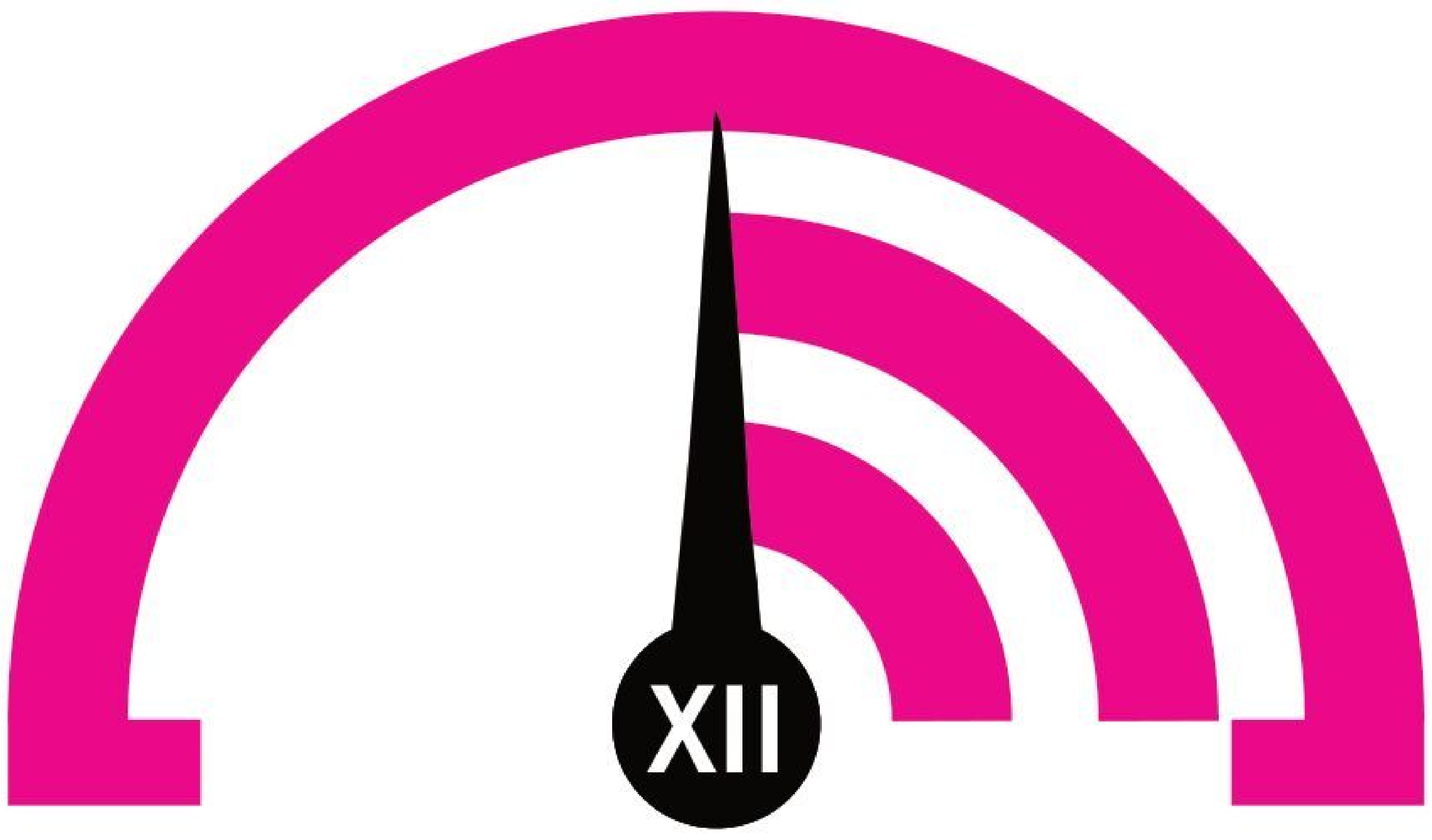
Ans. The ovum is released from the ovary in the secondary oocyte stage.

5. What would happen if sperms are devoid of their tail?

Ans. The tail helps in the movement of the sperm in the female genital tract. If the tail is removed, the sperm is unable to move and loses its capability to show movement in the female genital and loses its ability to fuse with the ova.

☺☺

MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 160

Complete Syllabus

Time : 40 Min.

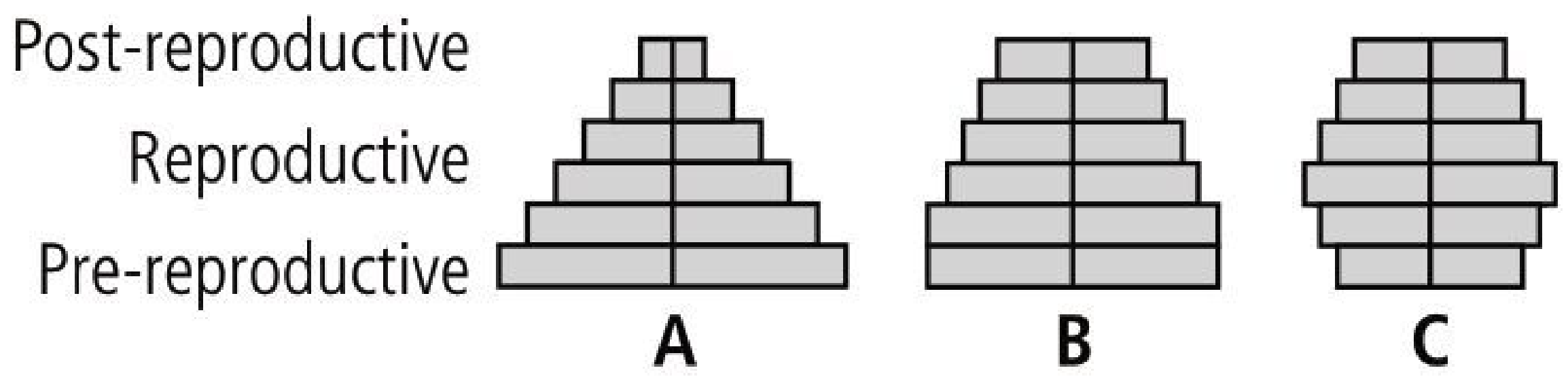
1. Select the correct match regarding scientists and vaccines discovered by them.
(a) Diphtheria antitoxin - Emil von Behring
(b) Hepatitis B - Robert Koch
(c) Yellow Fever - Edward Jenner
(d) Rabies - Jonas Salk

2. The following events occur during protein synthesis.
(i) Entry of another amino acyl-*t*RNA into A site.
(ii) Aminoacylation of *t* RNA.
(iii) Joining of larger subunit to form 70 S complex.
(iv) Binding of N-formyl methionine *t*RNA to the P-site of the ribosome.
(v) Formation of peptide bond between first and second amino acids at the A-site.
(vi) Release of the complete polypeptide chain from *m* RNA and the ribosomes.
(vii) Migration of dipeptide from A site to P site to form a tripeptide and then a polypeptide.

The correct order of the events will be
(a) (iii)–(ii)–(i)–(iv)–(v)–(vi)–(vii)
(b) (i)–(ii)–(iii)–(iv)–(v)–(vi)–(vii)
(c) (iii)–(i)–(ii)–(v)–(iv)–(vi)–(vii)
(d) (ii)–(iv)–(iii)–(i)–(v)–(vii)–(vi)

3. Which of the following ecosystems is most productive in terms of net primary production?
(a) Deserts
(b) Tropical rain forests
(c) Deep oceanic ecosystem
(d) Estuaries

4. Carefully observe the given age pyramids for human population and select the correct option.



(a) In pyramid A, rate of population growth is directly proportional to pre-reproductive population.
(b) Pyramid B represents the diminishing population with negative growth.
(c) Population represented by pyramid C is neither growing nor diminishing.
(d) Both pyramids A and B show expanding population.

5. What is recommended sulphur content in diesel fuels as per Euro VI norms?
(a) 50 ppm (b) < 10 ppm
(c) > 20 ppm (d) 35 ppm

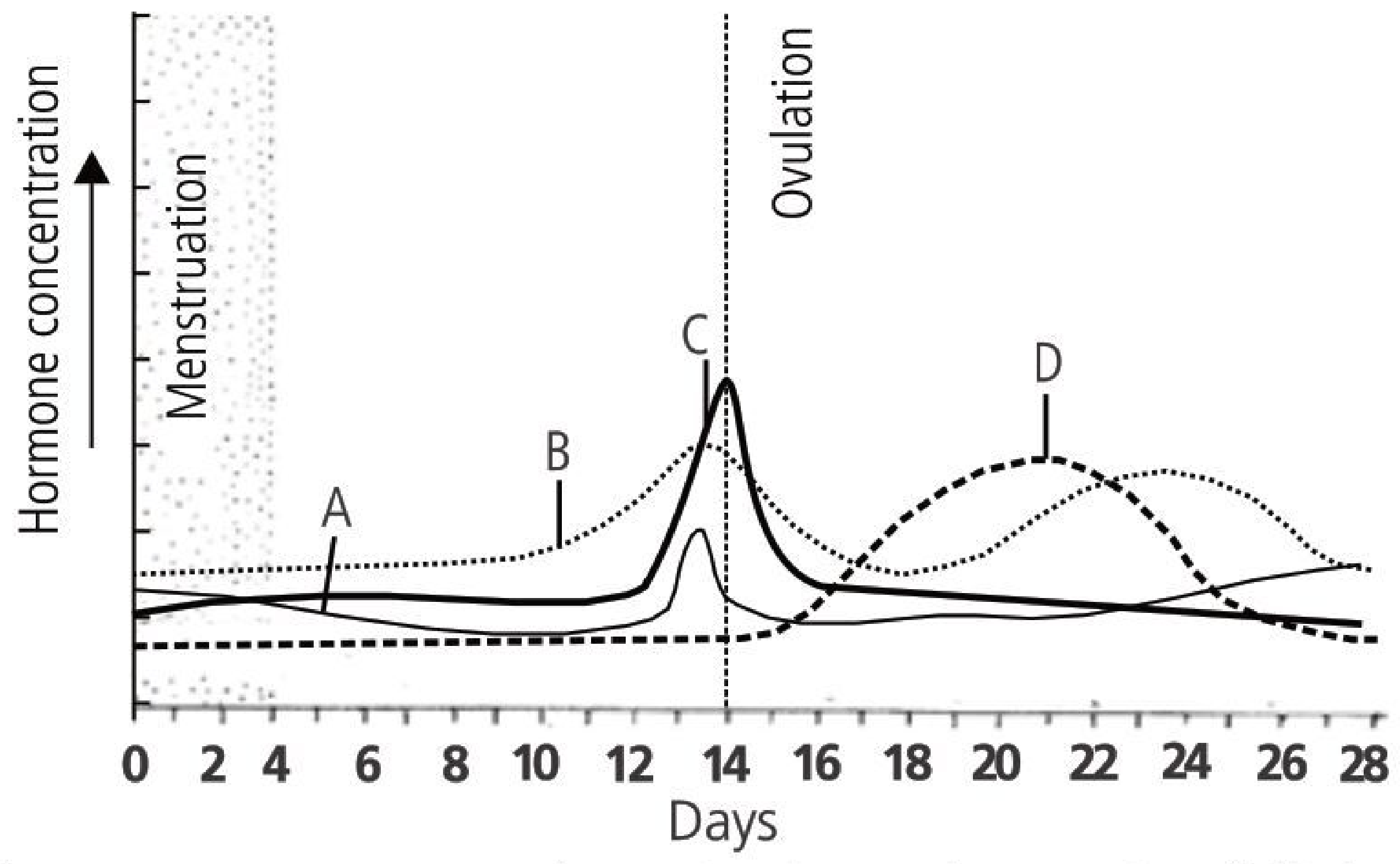
6. Choose the correct pairs from the following.
(i) *Bacillus thuringiensis* - Cry protein
(ii) Mycorrhiza - Leguminous plants
(iii) Statins - Inhibit cholesterol synthesis
(iv) *Trichoderma polysporum* - Cyclosporin A
(a) (i), (ii) and (iii) (b) (i), (ii) and (iv)
(c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

7. Karan Swiss is a high milk yielding cross-breed of
(a) Tharparkar cow × Sahiwal bull
(b) Sahiwal cow × Jersey bull
(c) Sahiwal cow × Brown Swiss bull
(d) Jersey cow × Brown Swiss bull.

8. In a double-stranded DNA, the sequence of base pairs in one strand is AGCTAAGC. What is the complementary sequence on the other strand?
(a) TCGATTCG (b) UCGAUUCG
(c) AGCTAAGC (d) CAUTAUCG

9. Select the mismatched pair.
(a) Wind - *Cannabis* - Entomophily
(b) Water - *Zostera* - Hydrophily
(c) Bird - *Bignonia* - Ornithophily
(d) Snail - *Arisaema* - Malacophily

10. Read the following statements for the given figure and select the incorrect ones.



(i) A represents FSH that stimulates the ovarian follicle to secrete estrogen.
(ii) C represents LH which induces rupturing of Graafian follicle and thereby the release of ovum.
(iii) B represents estrogen which stimulates the uterine glands to produce increased amount of watery mucus.
(iv) D represents progesterone which stimulates the proliferation of the endometrium of uterine wall.
(a) (ii), (iii) and (iv) (b) (i), (ii) and (iv)
(c) (i) and (iii) (d) (iii) and (iv)

11. Read the following statements and select the correct option.
(i) Allergy is the hyposensitiveness of a person to some foreign particles entering into the body.
(ii) Tonsil is a bean shaped organ which produces lymphocytes.
(iii) Antigen binds to a macrophage to reach a helper T-cell to initiate immune response.
(iv) IgM has a J chain and its each dimer contains secretory component.
(a) (i) only (b) (i), (ii) and (iv)
(c) (ii) and (iv) (d) (iii) and (iv)

12. Read the given statements and select the correct option.
Statement A : Colostrum provides passive immunity to the newborn.
Statement B : Colostrum is rich in immunoglobulin IgA.
(a) Both statements A and B are correct.
(b) Statement A is incorrect but B is correct.
(c) Statement A is correct but B is incorrect.
(d) Both statements A and B are incorrect.

13. Rancidity of butter is due to the formation of
(a) gluconic acid (b) butyric acid
(c) lactic acid (d) citric acid.

14. Which of the following is not a strategy for biodiversity conservation?
(a) Protection of all threatened species.
(b) Preservation of unique ecosystems on priority basis.
(c) Implementation of National Wildlife Laws.
(d) Planting of sal and teak trees in pure strands to increase forest cover.

15. Match column I with column II and select the correct option from the codes given below.

	Column I		**Column II**
A.	STDs caused by bacteria	(i)	Scabies
B.	STDs caused by virus	(ii)	Gonorrhoea
C.	STDs caused by arthropods	(iii)	Genital warts
D.	STDs caused by protozoa	(iv)	Giardiasis

(a) A-(i); B-(ii); C-(iv); D-(iii)
(b) A-(ii); B-(iv); C-(i); D-(iii)
(c) A-(i); B-(ii); C-(iii); D-(iv)
(d) A-(ii); B-(iii); C-(i); D-(iv)

16. After penetrating stigmatic and stylar tissue, the pollen tube usually grows towards egg because
(a) there is no other path to follow
(b) it grows under the control of egg nucleus
(c) it is attracted by antipodals by their secretion
(d) the filiform apparatus of synergids is believed to guide the pollen tube by their secretion.

17. Which chromosomal formulation is responsible for the expression of metafemale character in *Drosophila*?
(a) 2A + 3X (b) 3A + 3X
(c) 4A + 3X (d) 3A + XY

18. Refer to the given statements.
(i) Suspension culture grows slowly as compared to callus culture.
(ii) Explants used in meristem culture are shoot tips and nodal segments.
(iii) Anther culture produces haploids that are sterile and have only one copy of each chromosome.
(iv) Somaclones are genetically identical plants developed from any part of a plant by tissue culture.
Which of the following statement(s) is/are correct?
(a) (i) and (ii) (b) (i), (iii) and (iv)
(c) (ii), (iii) and (iv) (d) (iv) only

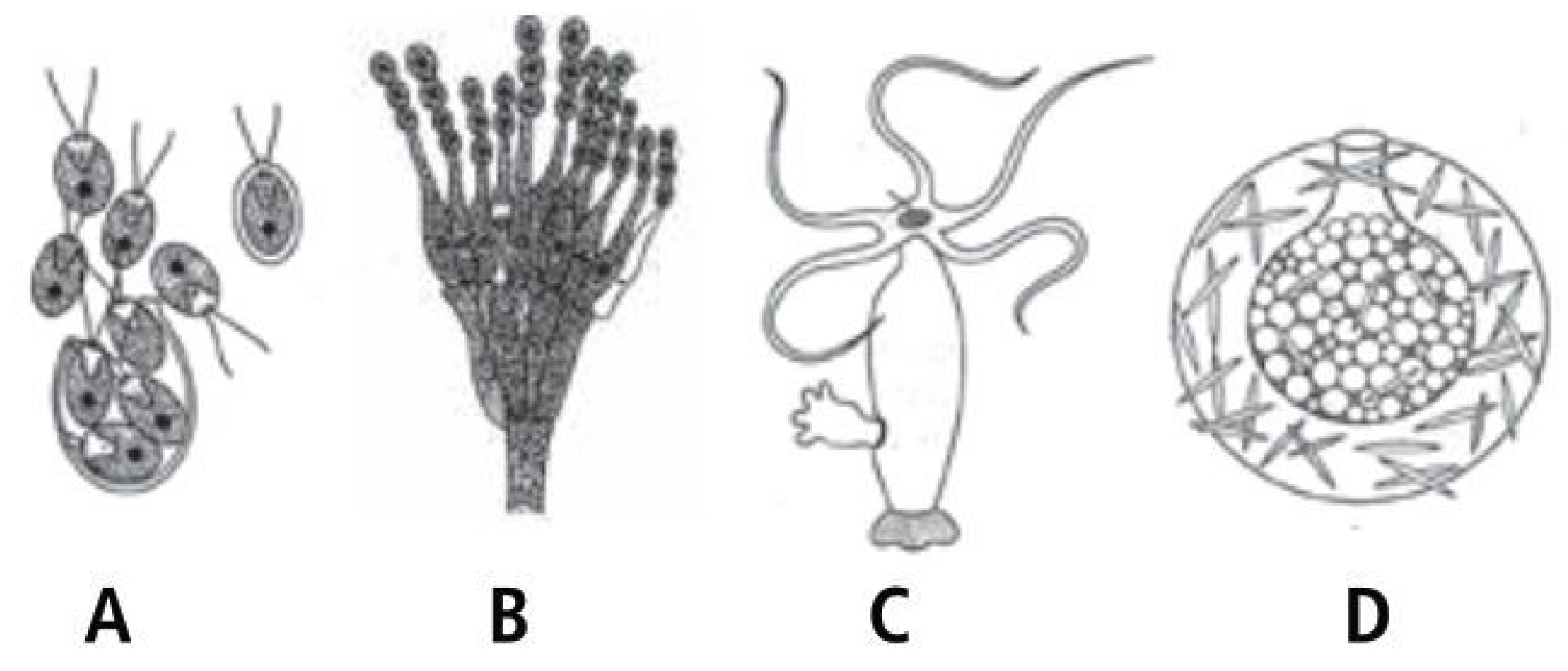
19. Which of the following methods is/are used in vectorless gene transfer?
(a) Microinjection
(b) Transformation
(c) Insertional inactivation
(d) Both (a) and (c)

20. Select the correct option regarding the ploidy level of different structures of an angiospermic ovule.

	Synergid	**Nucellus**	**Antipodal**	**Egg**
(a)	n	n	2n	2n
(b)	n	2n	n	n
(c)	n	2n	2n	n
(d)	n	n	n	2n

21. Transcription in prokaryotes requires
(a) RNA dependent RNA polymerase
(b) DNA dependent RNA polymerase
(c) endogenous DNA polymerase
(d) DNA dependent DNA polymerase.

22. Refer to the given figures.



All of these are
(a) bodies involved in sexual reproduction
(b) bodies involved in asexual reproduction
(c) endogenous structures
(d) both (b) and (c).

23. Consider the following statements and select the correct option stating which ones are true (T) and which ones are false (F).
I. Macrophytes are the major producers of deep aquatic systems.
II. Standing crop is the amount of living biomass present in a unit area of an ecosystem.
III. Emigration is the entry of some new alleles into the gene pool.
IV. Natality maintains the health of the population.

	I	**II**	**III**	**IV**
(a)	T	T	T	F
(b)	F	T	F	F
(c)	T	F	T	F
(d)	F	F	T	T

24. The enzyme transcribed by structural gene Y in *lac* operon of *E.coli*, is
(a) permease (b) β-galactosidase
(c) transacetylase (d) none of these.

25. Which among the given diseases are caused by bioweapon agents?
(i) Small pox (ii) Emphysema
(iii) Plague (iv) Asthma
(v) Q-fever (vi) Viral encephalitis
(a) (i), (iii), (v) and (vi) only
(b) (ii), (iii) and (iv) only
(c) (i), (iv) and (vi) only
(d) (i), (ii), (iv) and (v) only

26. _A_ is a methane rich fuel gas produced by _B_ breakdown of biomass with the help of _C_ bacteria.
(a) A-CNG, B-aerobic, C-methanogenic
(b) A-Biogas, B-anaerobic, C-methanogenic
(c) A-LPG, B-anaerobic, C-Gram negative
(d) A-Biogas, B-aerobic, C-methanogenic

27. Which of the following is/are not the derivatives of mesoderm?
(i) Cortex of adrenal glands
(ii) Coelomic epithelium
(iii) Epithelium of Eustachian tube
(iv) Conjunctiva
(v) Terminal part of male urethra
(a) (ii) and (iii) (b) (i), (iii) and (iv)
(c) (iii), (iv) and (v) (d) (ii), (iii), (iv) and (v)

28. Match the following columns and select the correct option.

Column I	**Column II**	**Column III**
(i) Ozone depletion	(A) H_2S, SO_2	(p) Climate change
(ii) Global warming	(B) CFC, NO	(q) Skin cancer
(iii) Acid rain	(C) SO_2, NO_x, VOCs	(r) Lung and throat diseases
(iv) Smog	(D) CO_2, CH_4	(s) Stone leprosy

(a) (i)-(B)-(q); (ii)-(D)-(p); (iii)-(C)-(s); (iv)-(A)-(r)
(b) (i)-(B)-(r); (ii)-(C)-(q); (iii)-(D)-(p); (iv)-(A)-(s)
(c) (i)-(D)-(q); (ii)-(B)-(p); (iii)-(C)-(r); (iv)-(A)-(s)
(d) (i)-(A)-(q); (ii)-(D)-(s); (iii)-(B)-(p); (iv)-(C)-(r)

29. Praying mantis has the ability to blend with its surroundings. The type of adaptation shown by this insect is
(a) mimicry (b) warning colouration
(c) camouflage (d) diapause.

30. In *Pisum sativum*, the axial (A) flower position is dominant and the terminal flower position (a) is recessive. Two pea plants were crossed, producing seeds that yielded 165 plants with axial flowers and 54 plants with terminal flowers. The genotypes of the parent plants were most likely
(a) Aa and AA (b) Aa and Aa
(c) aa and Aa (d) AA and aa.

31. According to Miller's experiment which of the following statements is/are incorrect?
(i) Miller circulated five gases *viz*. CH_4, NH_3, H_2, H_2O and CO_2 in an air tight apparatus.
(ii) The electrical discharge from electrodes were passed at 800°C.
(iii) Miller found formation of a large number of complex inorganic compounds.
(iv) Atmosphere inside the apparatus was reducing.
(a) (i) and (iv) (b) (i) and (iii)
(c) (i), (iii), and (iv) (d) (ii) and (iv)

32. Identify the chromosomal disorder which is due to nondisjunction of chromosome 21 and results in 47 chromosomes in an offspring.

(a) Turner's syndrome (b) Down's syndrome
(c) Klinefelter's syndrome
(d) Patau's syndrome

33. Which of the following sequences is recognised by *Hin*d III?

(a) $\begin{array}{l} 5' - A{-}G\overset{\downarrow}{-}C{-}T - 3' \\ 3' - T{-}C\underset{\uparrow}{-}G{-}A - 5' \end{array}$ (b) $\begin{array}{l} 5' - A\overset{\downarrow}{-}A{-}G{-}C{-}T{-}T - 3' \\ 3' - T{-}T{-}C{-}G{-}A\underset{\uparrow}{-}A - 5' \end{array}$

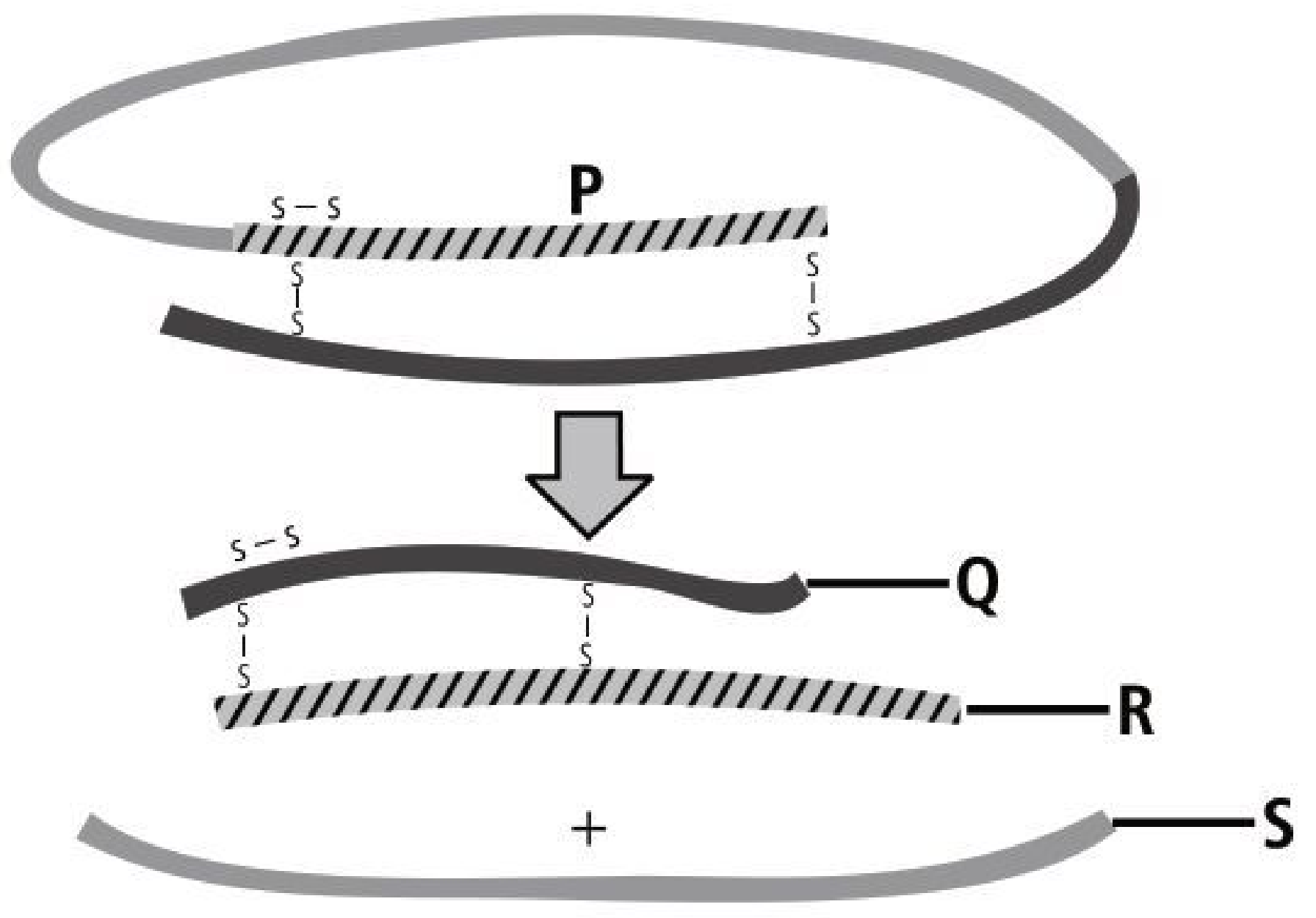
(c) $\begin{array}{l} 5' - C\overset{\downarrow}{-}C{-}T{-}G{-}G - 3' \\ 3' - G{-}G{-}A{-}C\underset{\uparrow}{-}C - 5' \end{array}$ (d) None of these

34. Select the correct statement regarding nutrient cycling.
(a) Sedimentary cycles are more rapid and perfect compared to gaseous cycles.
(b) There is no dissipation of nutrients at any level.
(c) Microorganisms have little role in maintaining nutrient cycles.
(d) Flow of nutrient circulation is always unidirectional.

35. Suppose a RNA molecule with repeating sequence of GU nitrogenous bases GUGUUAGUGUUA is synthesised. It produces a tetrapeptide with alternating sequence of valine and leucine. It proves that the codon for valine and leucine are
(a) GUU and AGU (b) GUG and GUU
(c) GUG and UUA (d) UGU and UAG.

36. Identify the type of biome from given characters.
(i) Highest altitudinal biome covered with snow.
(ii) Common animals include yak, wolves, snow leopard.
(iii) Trees like *Rhododendron*, *Juniperus* are present.
(a) Chaparral (b) Savanna
(c) Alpine tundra (d) Tropical rain forest

37. Given figure represents the synthesis of insulin. Select the correct statement regarding it.



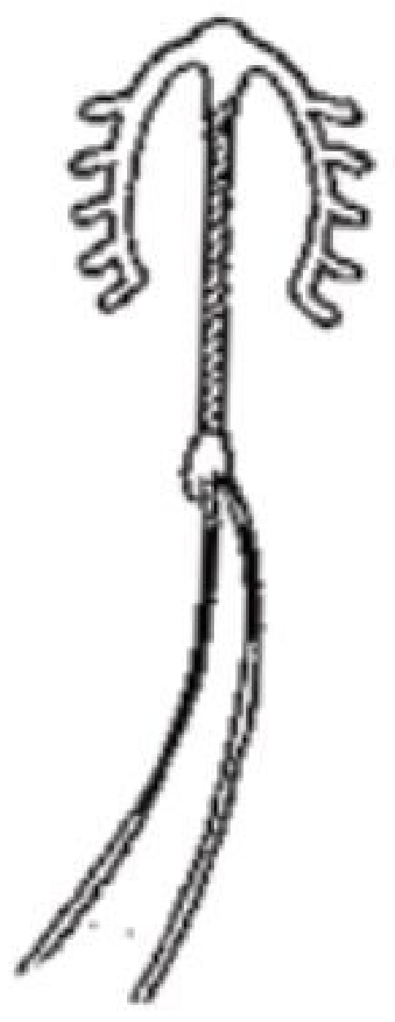
(a) Labelled part P consists of four chains A, B, C and D.
(b) Labelled part P matures to form R.
(c) Labelled part S contains 30 amino acids and is not present in mature insulin.
(d) None of these

38. Match column I with column II and select the correct option.

	Column I		**Column II**
A.	Hotspot	(i)	Sundarbans
B.	Wildlife sanctuary	(ii)	Khecheopalri in Sikkim
C.	National park	(iii)	Aravali hills in Rajasthan
D.	Sacred forest	(iv)	Western Ghats
		(v)	Bir Moti Bagh

(a) A-(iv), B-(v), C-(i), D-(iii)
(b) A-(iv), B-(i), C-(iii), D-(v)
(c) A-(i), B-(iii), C-(ii), D-(v)
(d) A-(iv), B-(v), C-(ii), D-(i)

39. Identify the given contraceptive device.



(a) Multiload 375 (b) Diaphragm
(c) CuT (d) Implant

40. Fill the blank spaces in the table given below by selecting the correct option.

	Genus	Epochs	Cranial capacity
(i)	*Australopithecus*	**A**	500cc
(ii)	**B**	Pleistocene	800-1100cc
(iii)	*Homo neanderthalensis*	Pleistocene	**C**
(iv)	*Homo sapiens*	**D**	1650 cc

(a) A-Miocene, B-*Homo habilis*, C-450 cc, D-Holocene
(b) A-Pliocene, B-*Homo erectus*, C-1300-1600cc, D-Holocene
(c) A-Holocene, B-*Homo sapiens*, C-700cc, D-Miocene
(d) A-Pleistocene, B-*Homo habilis*, C-1650cc, D-Miocene

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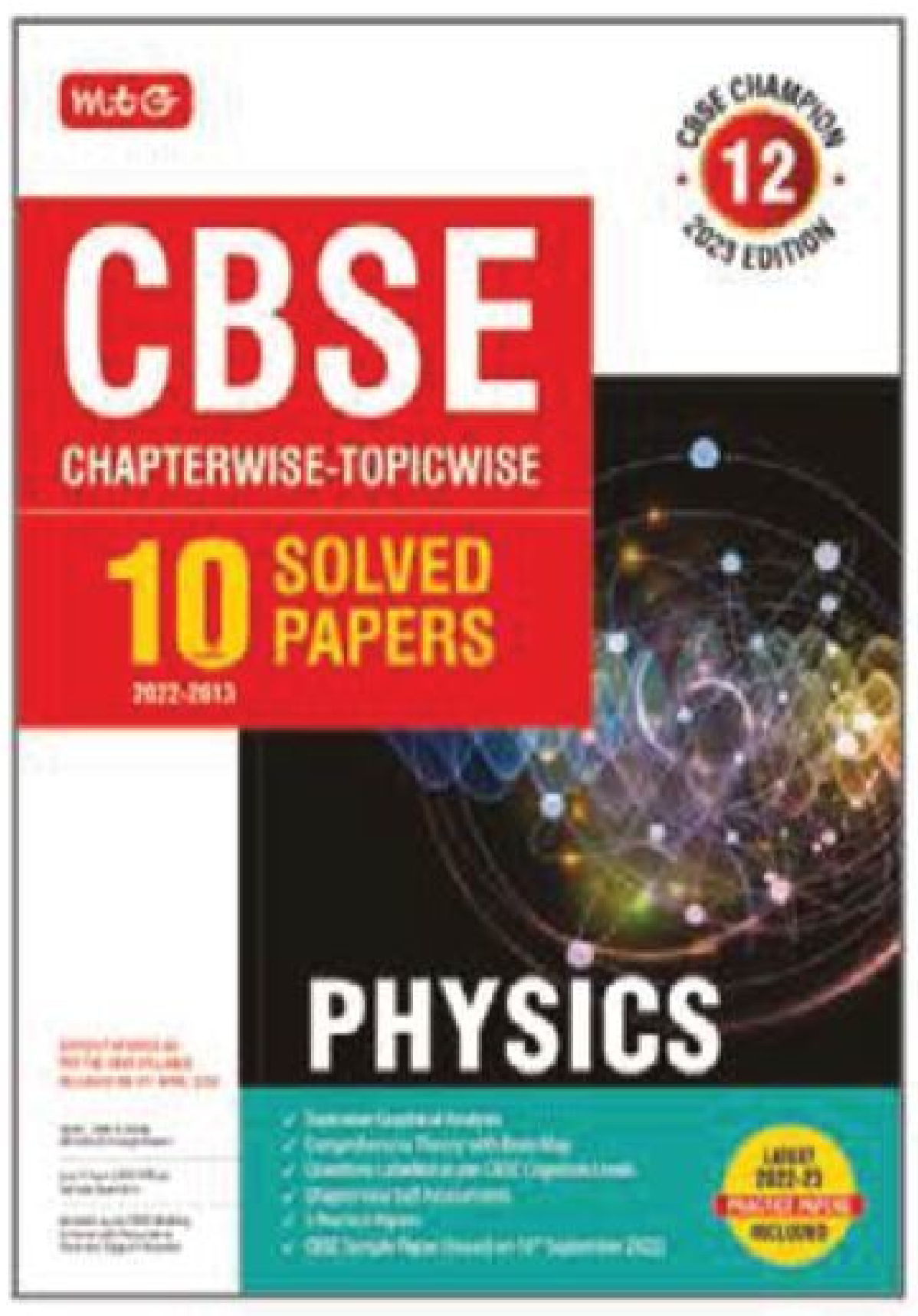
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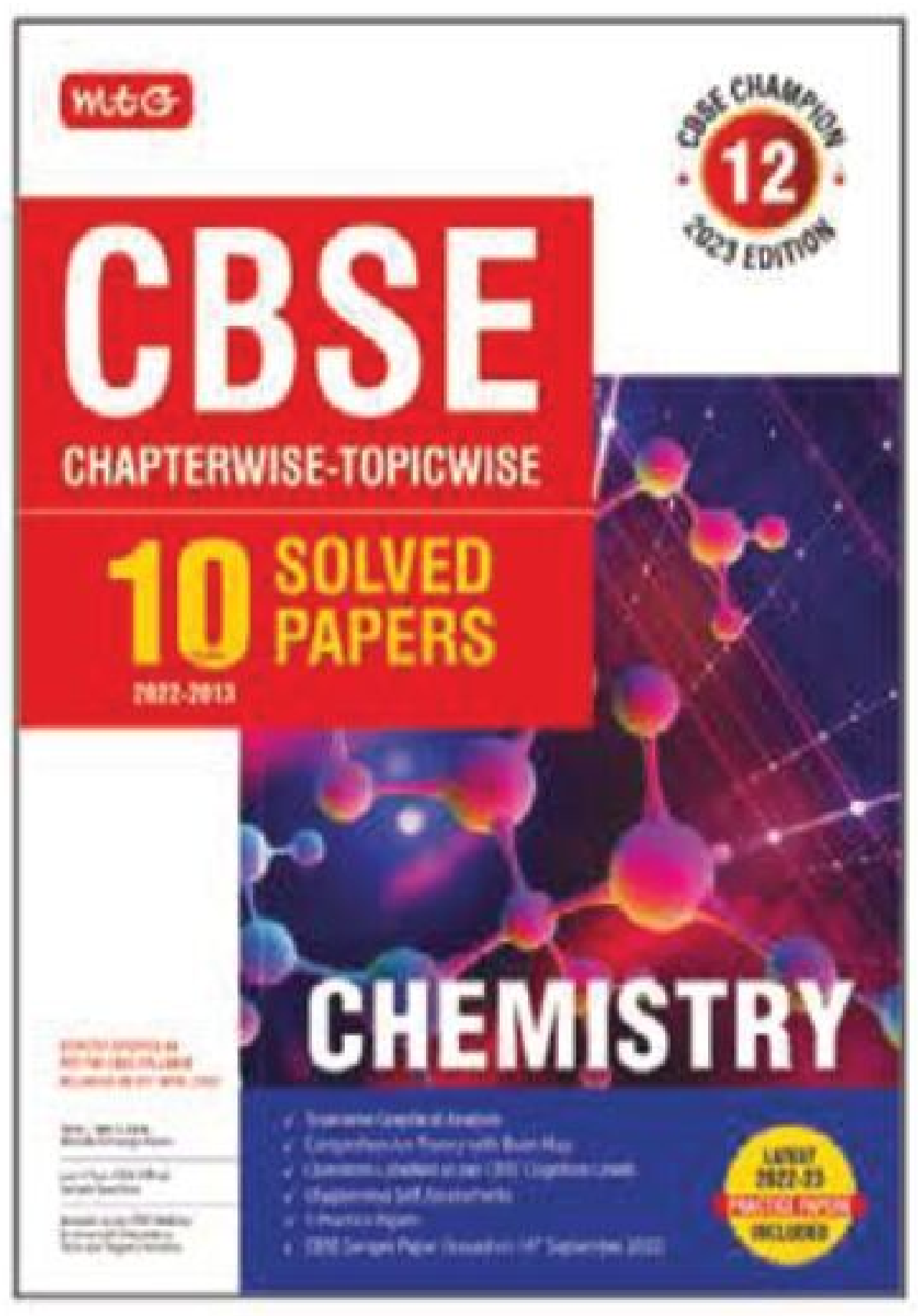
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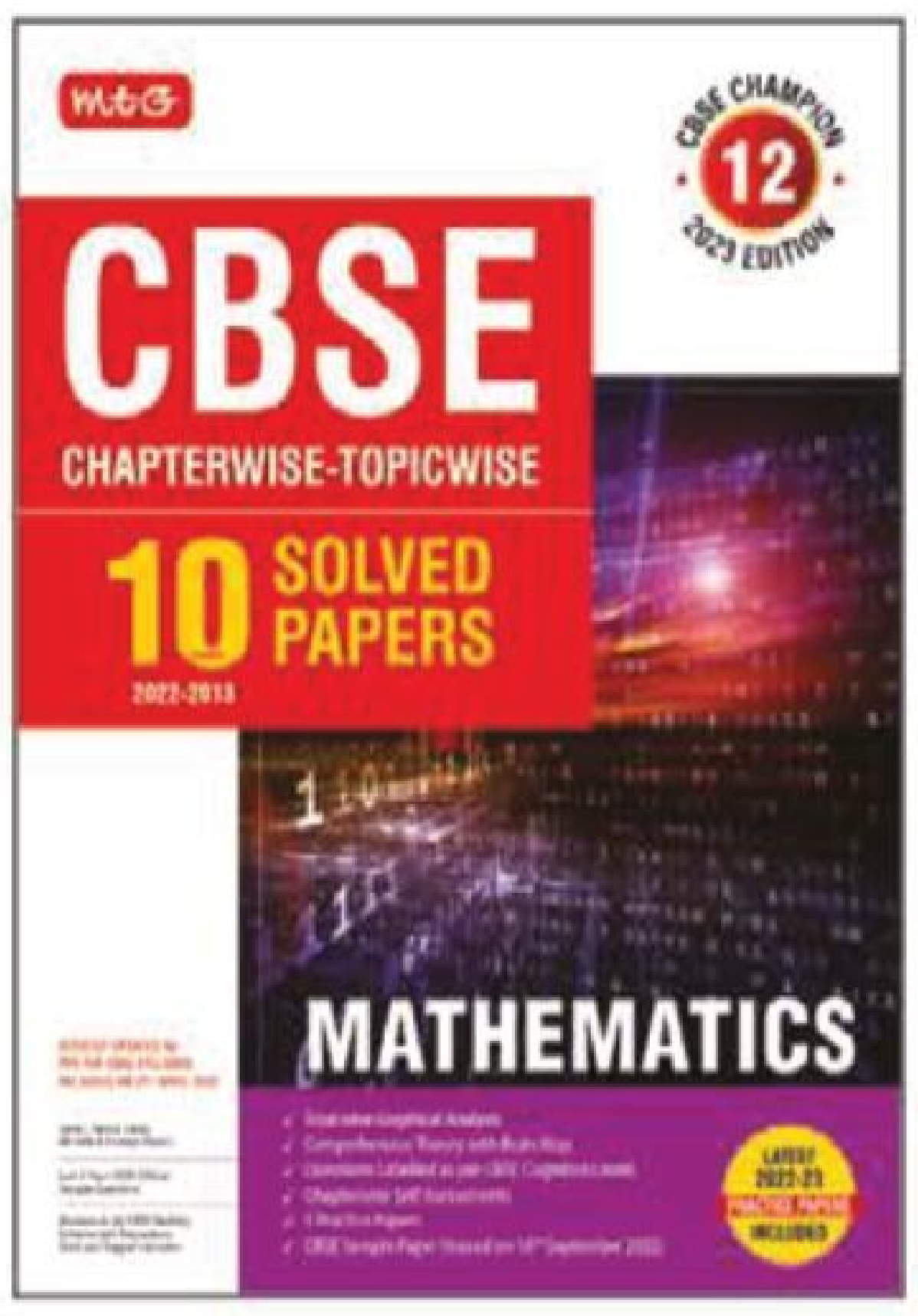
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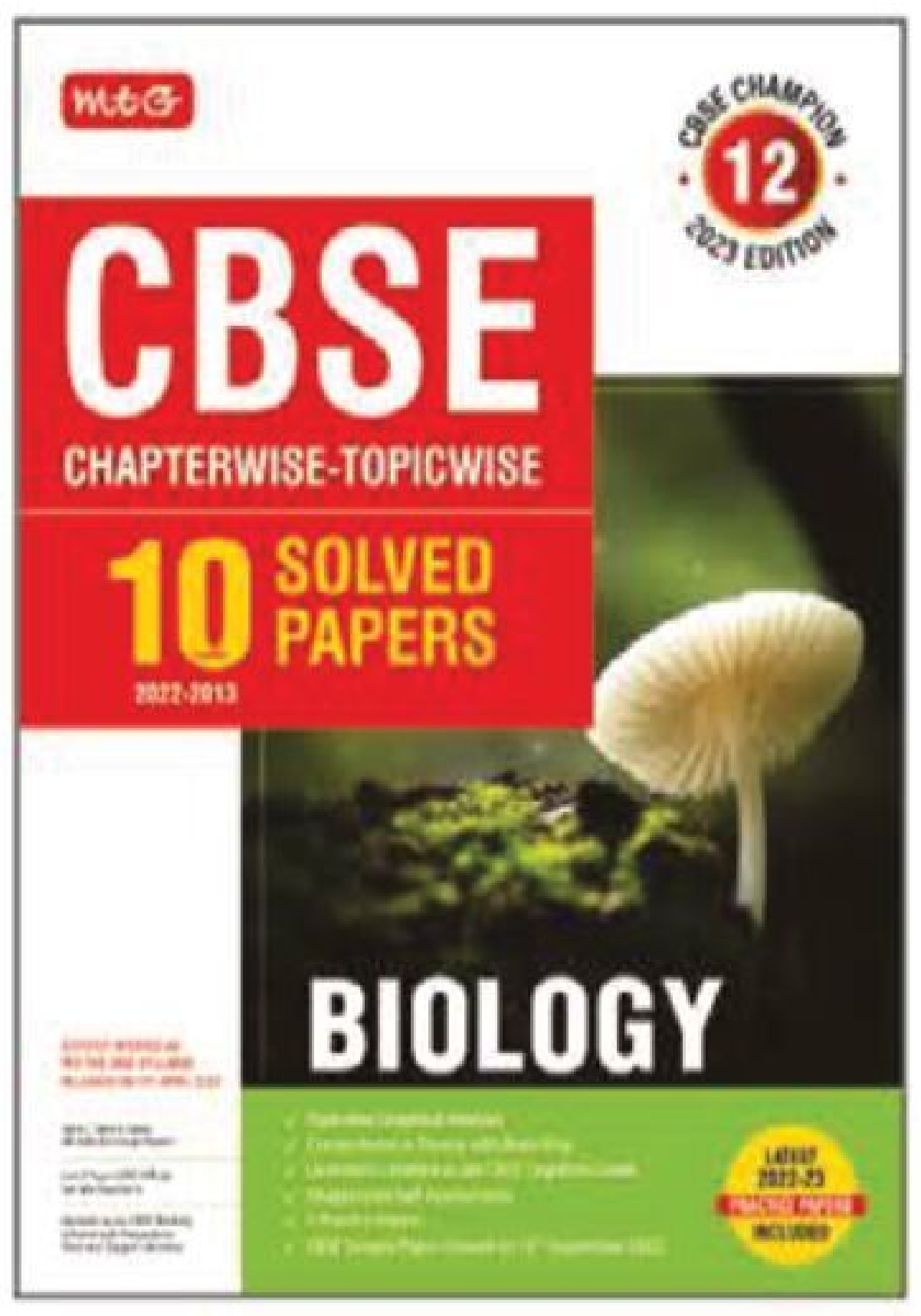
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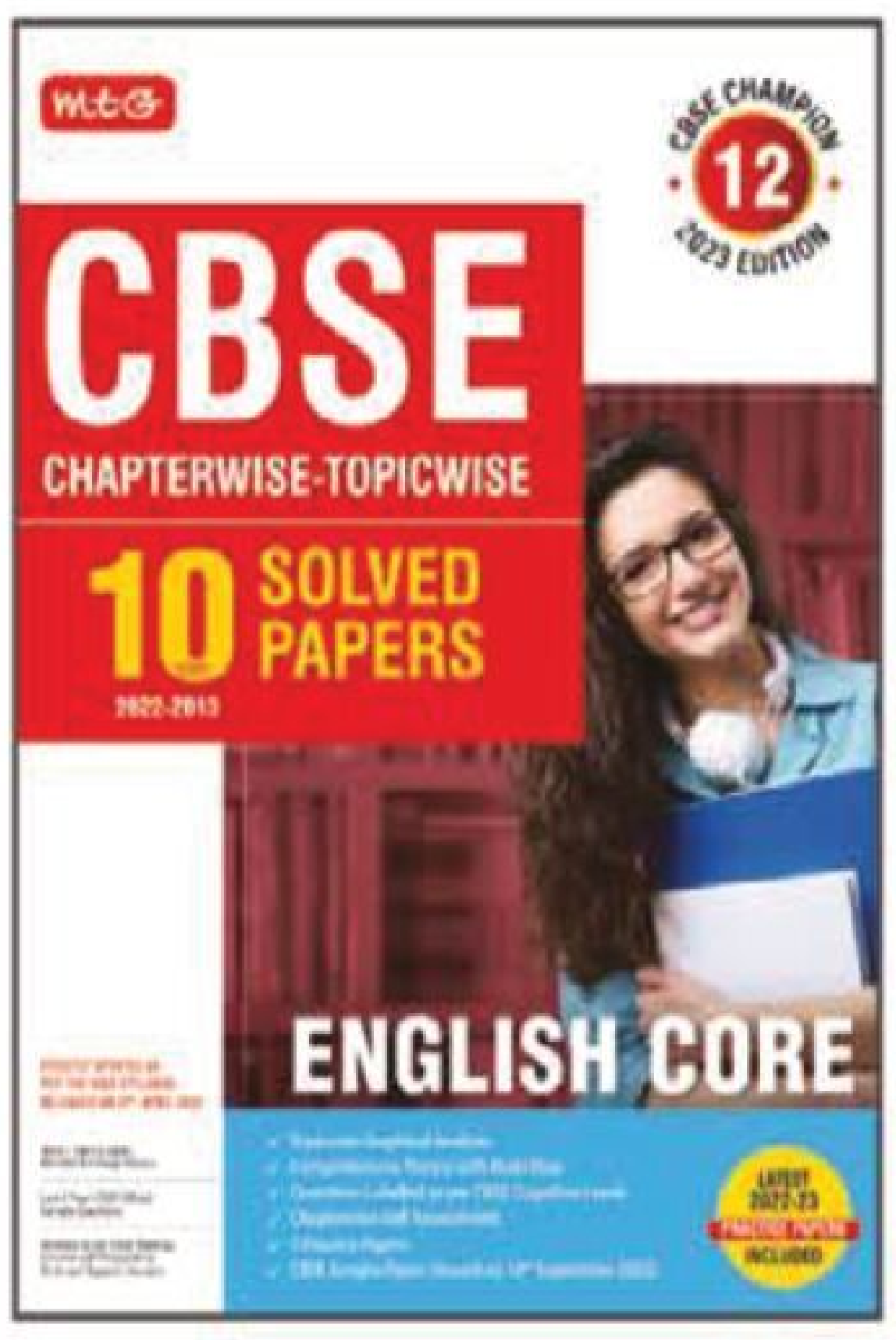
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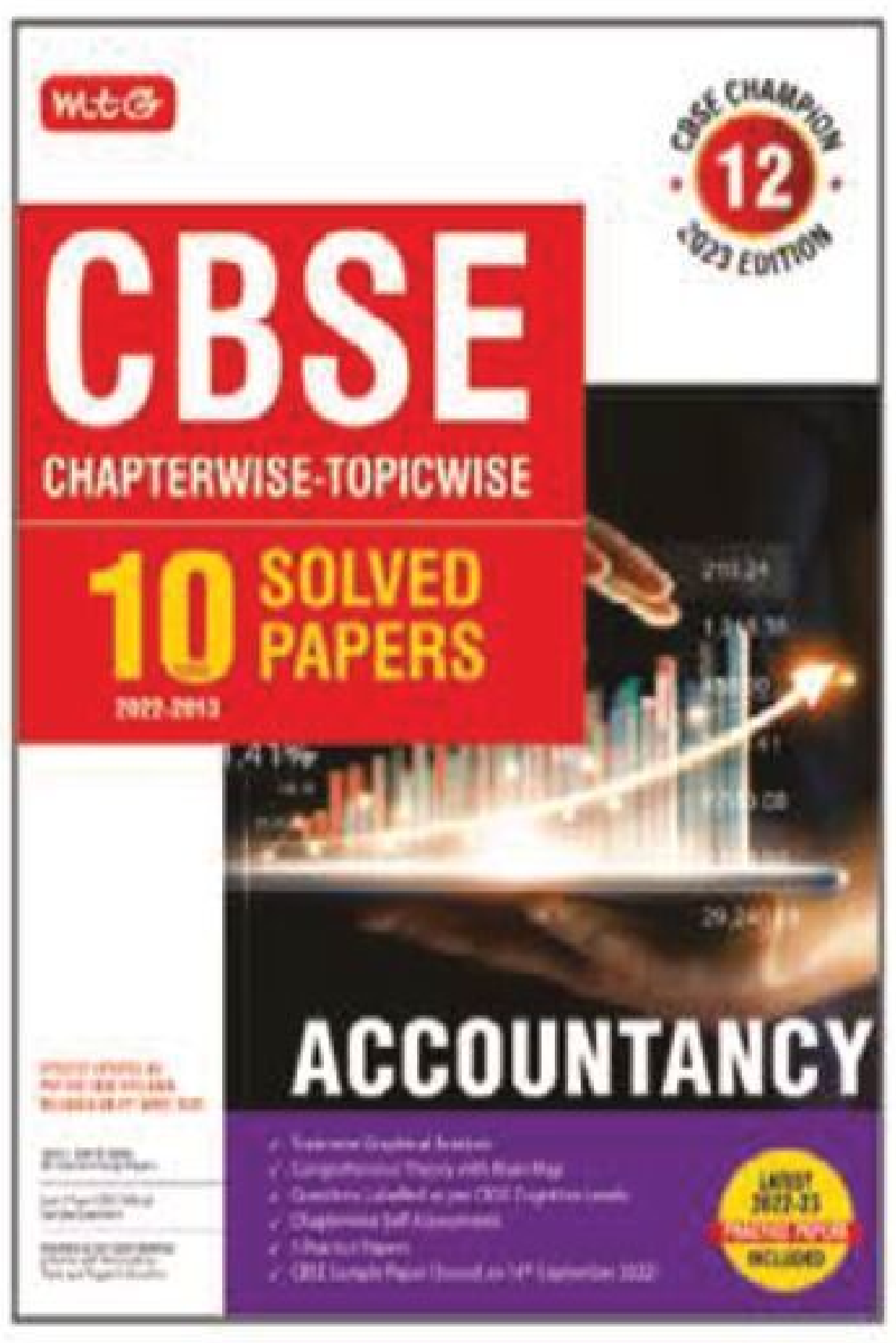
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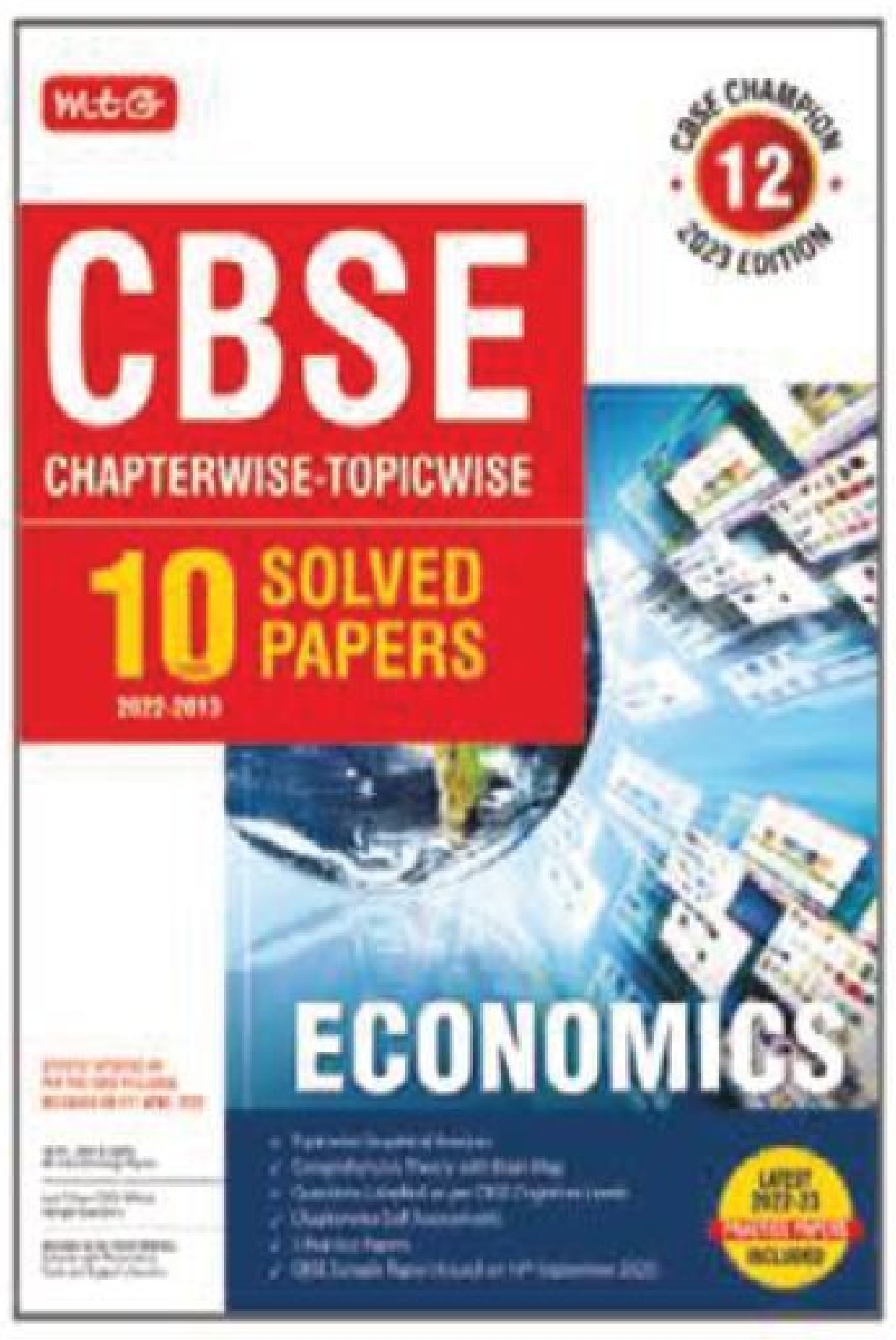
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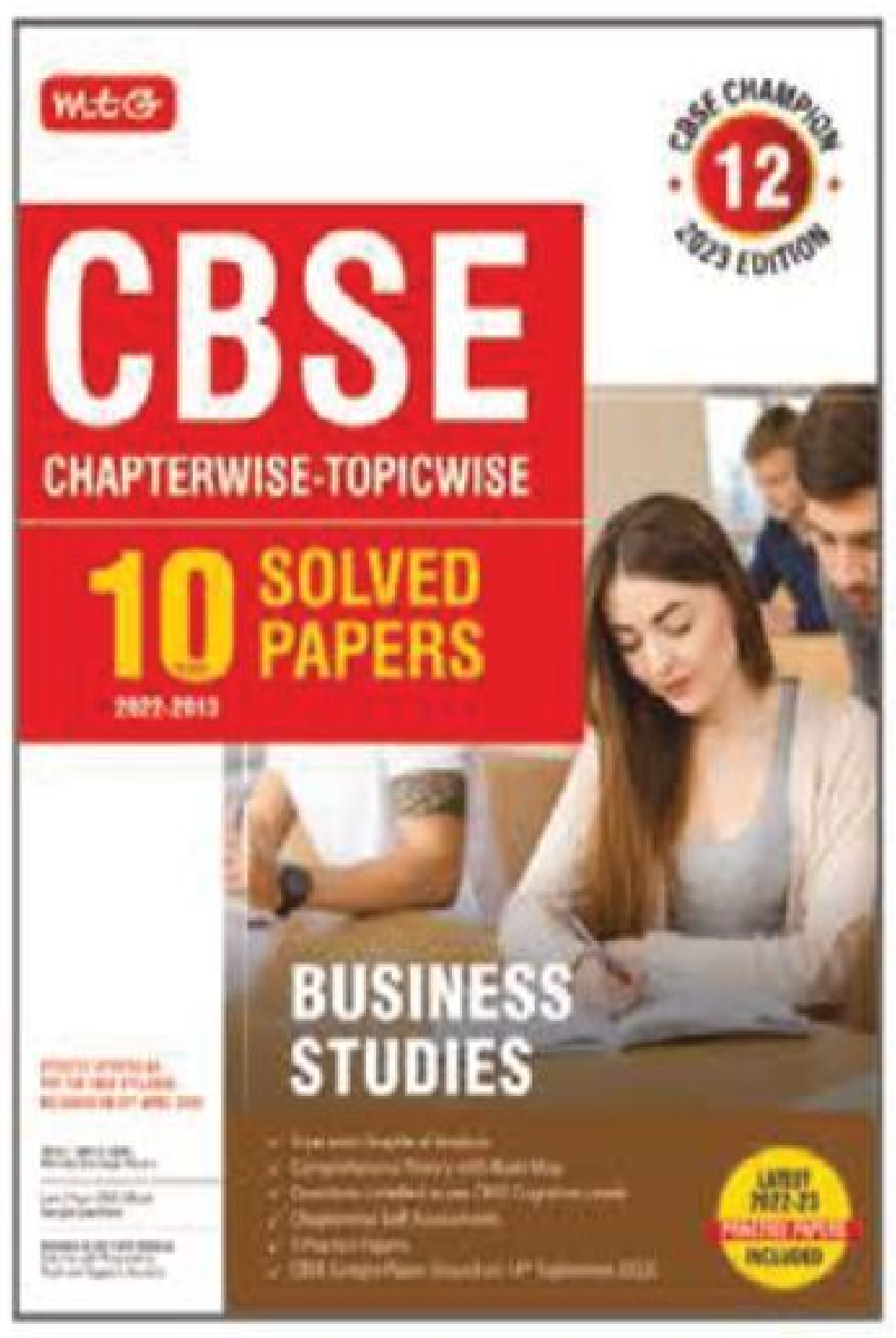
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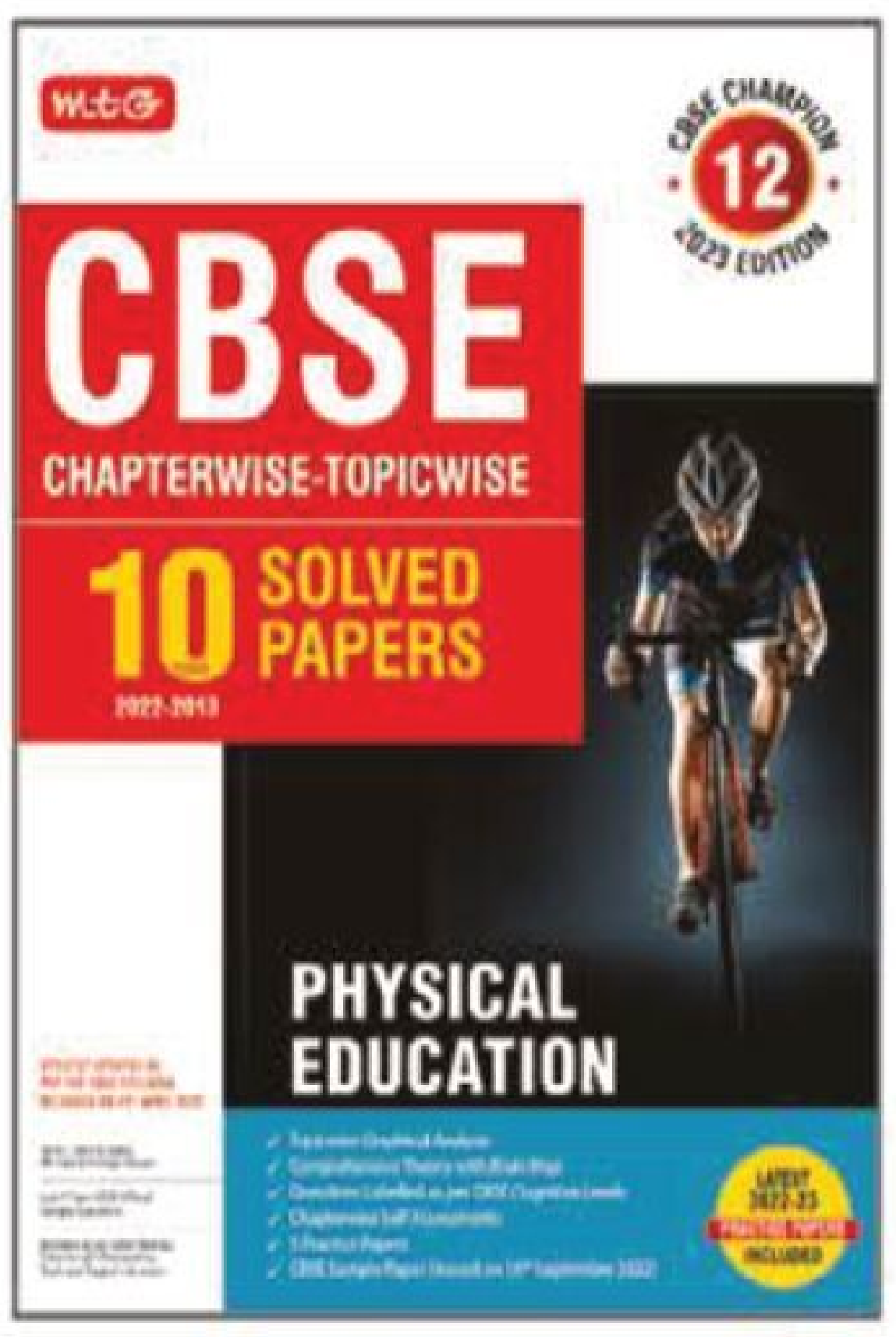
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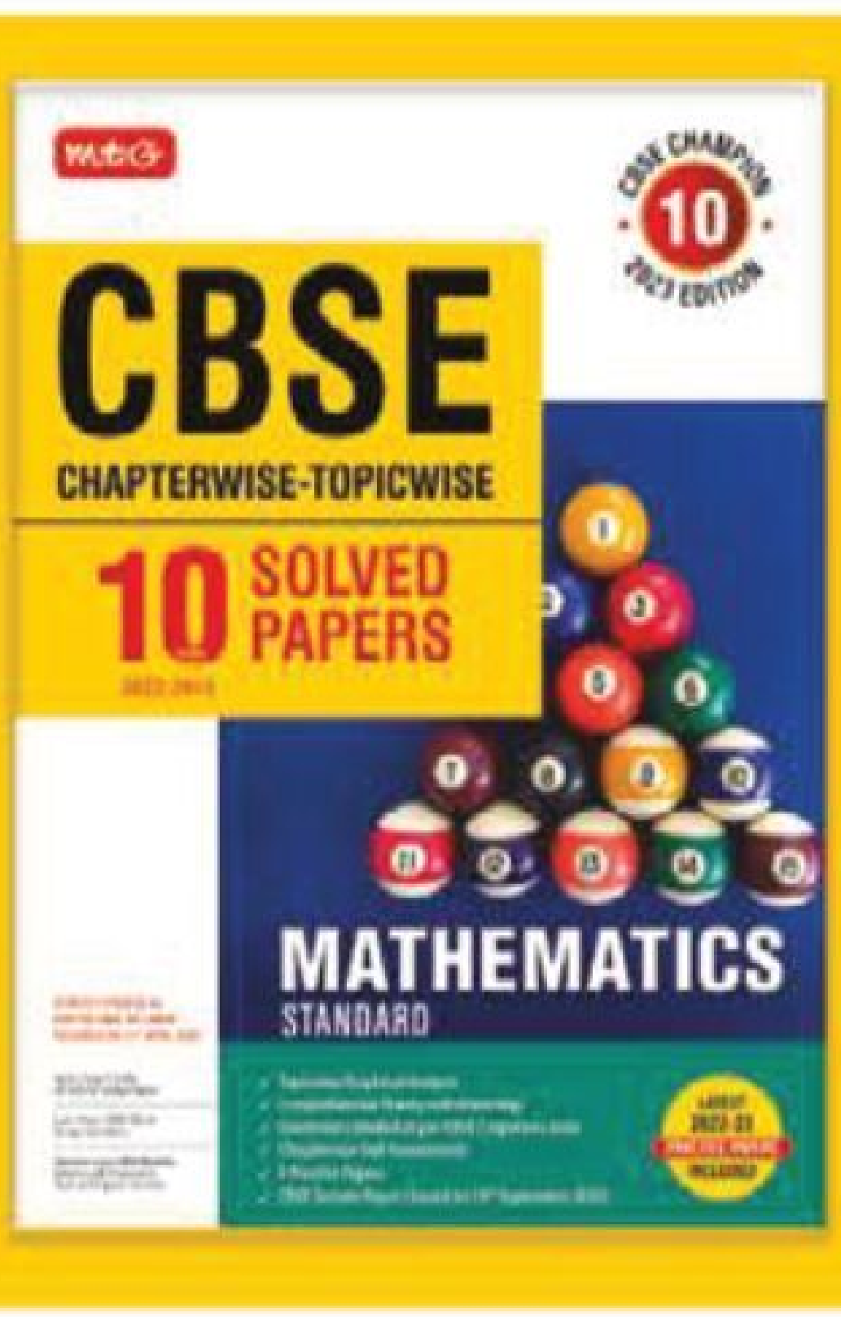
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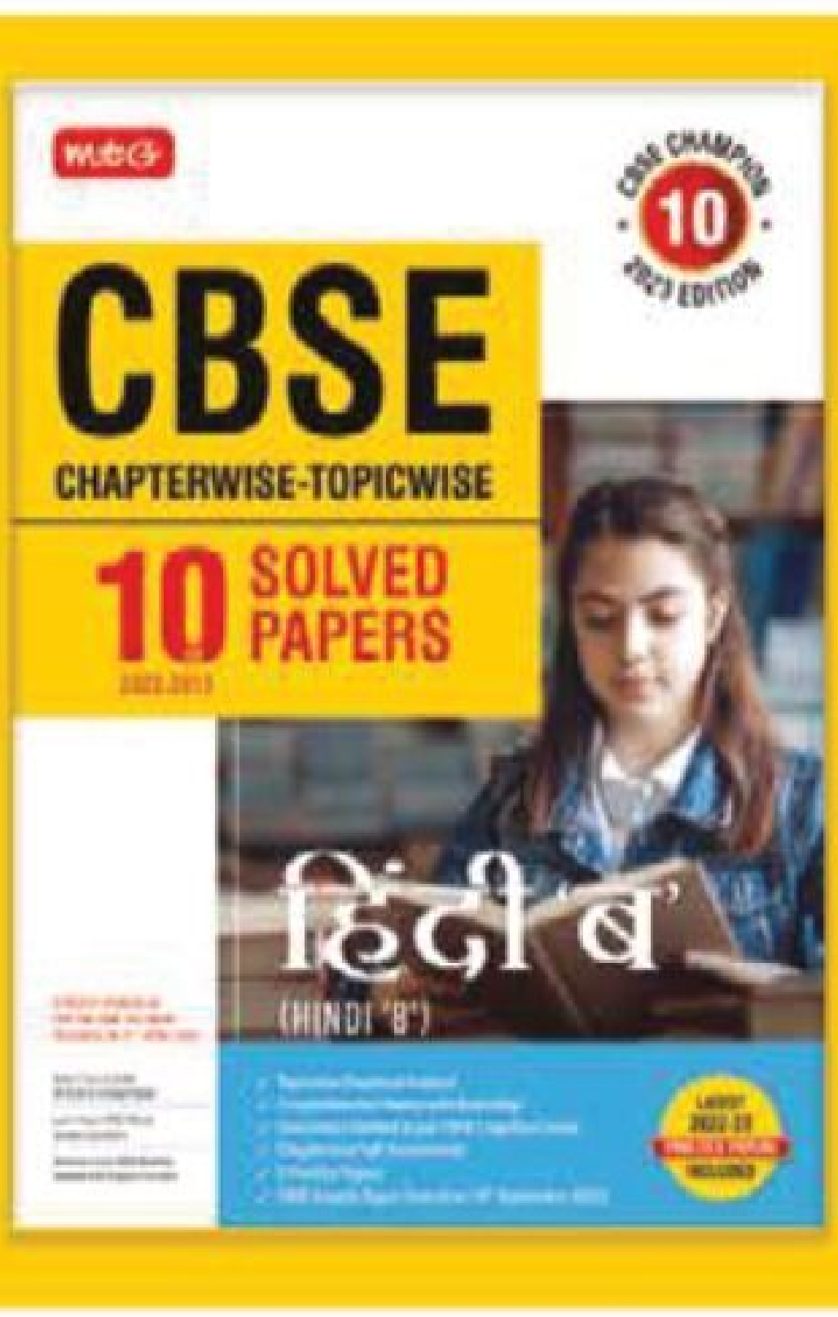
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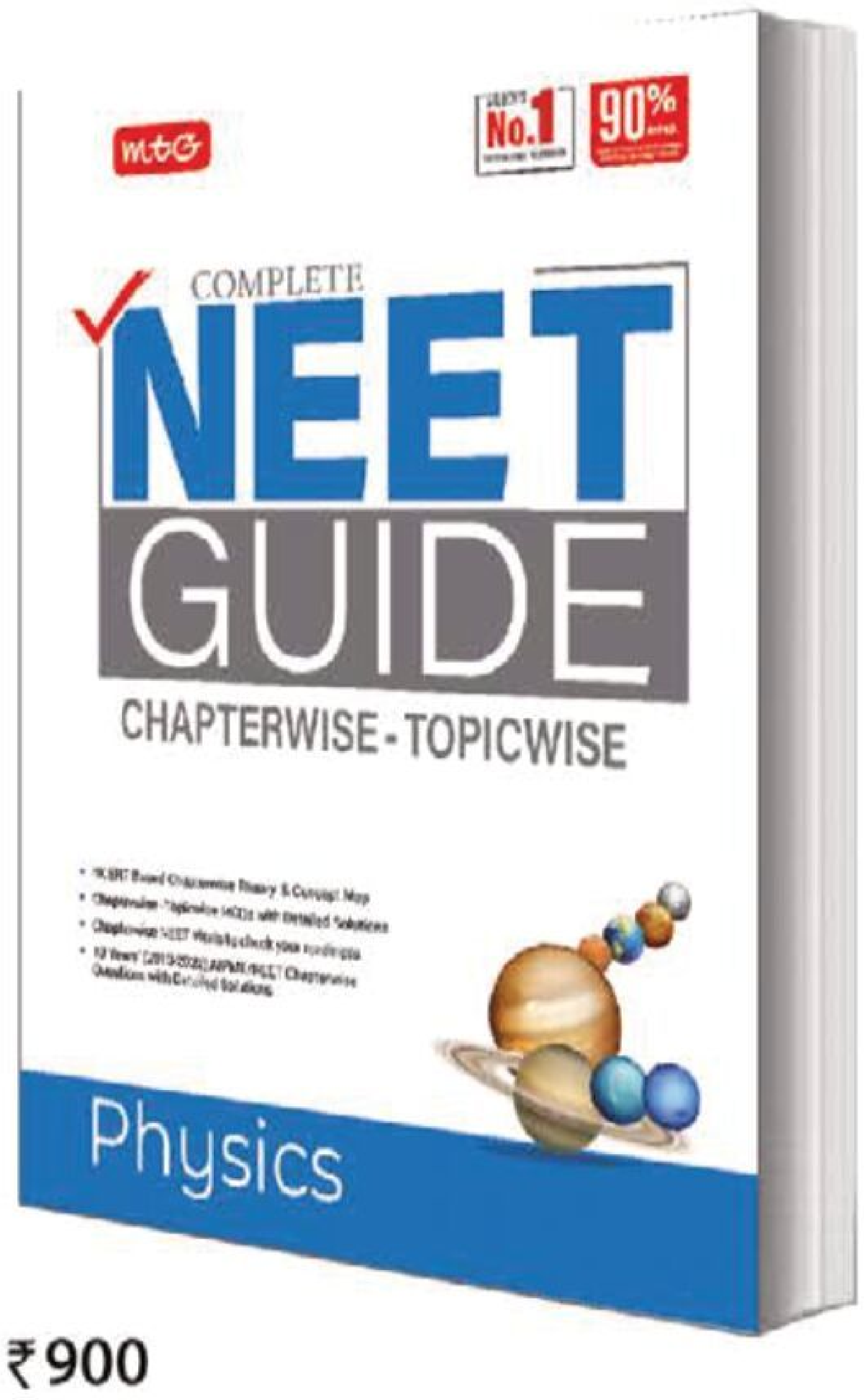
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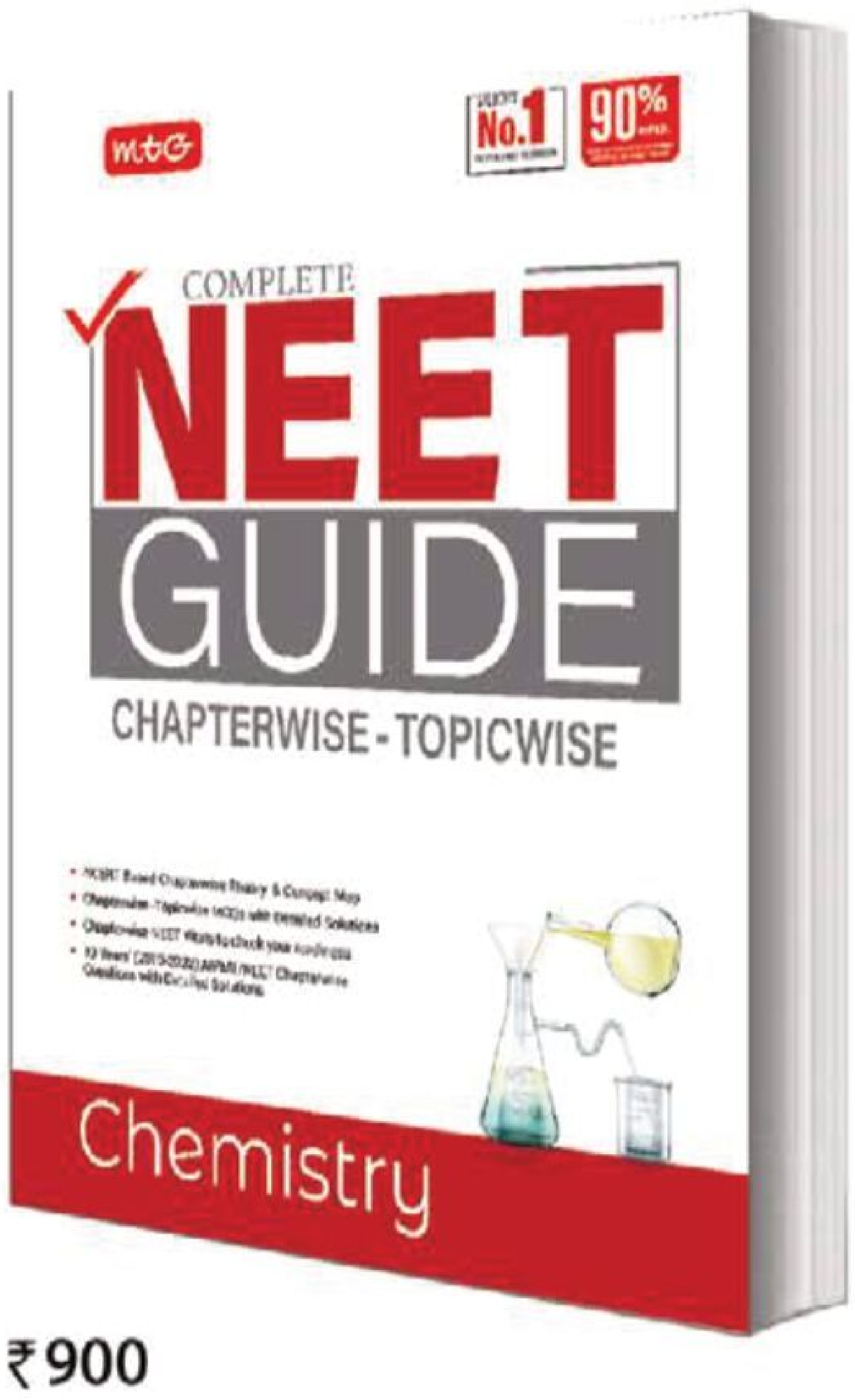
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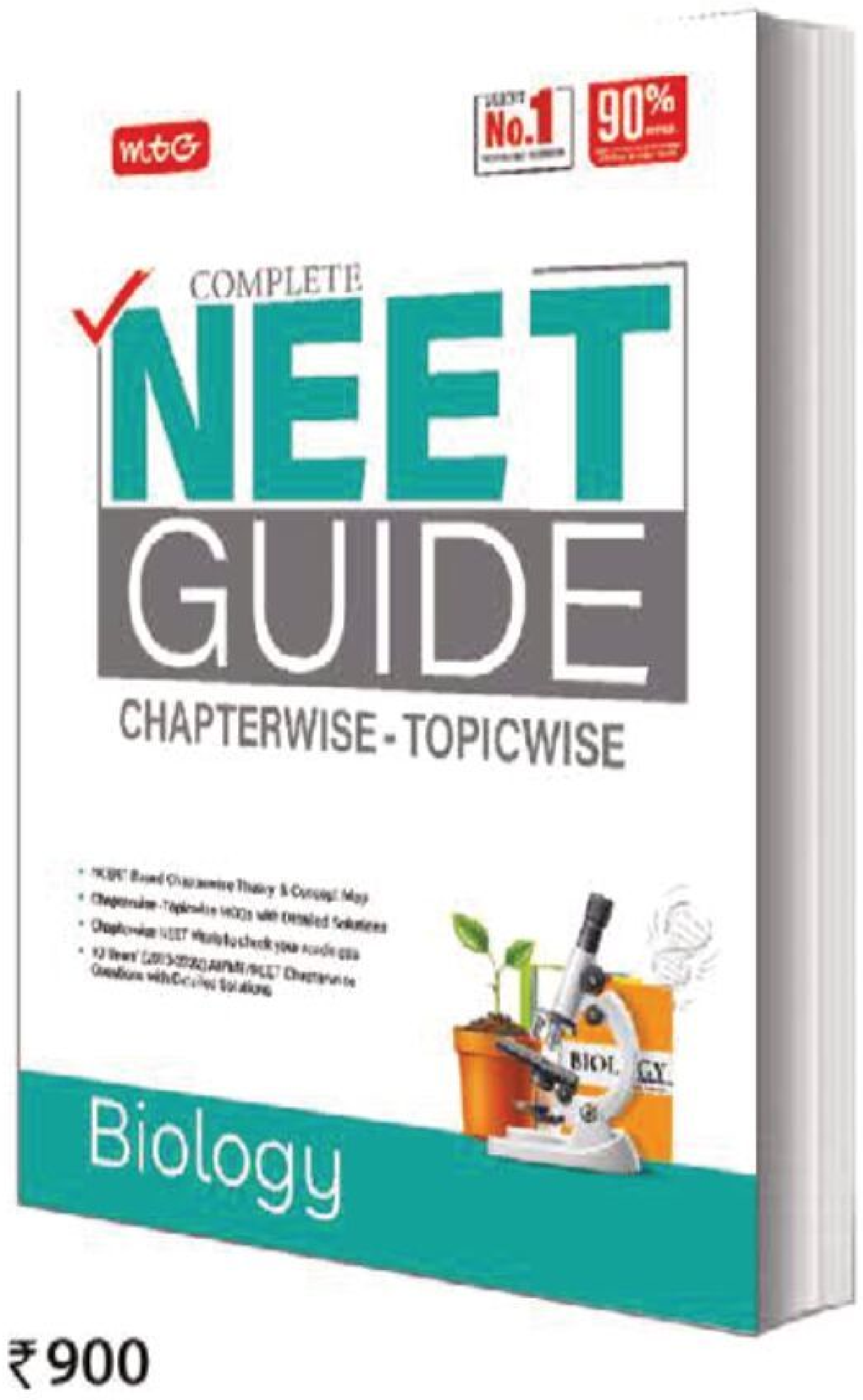
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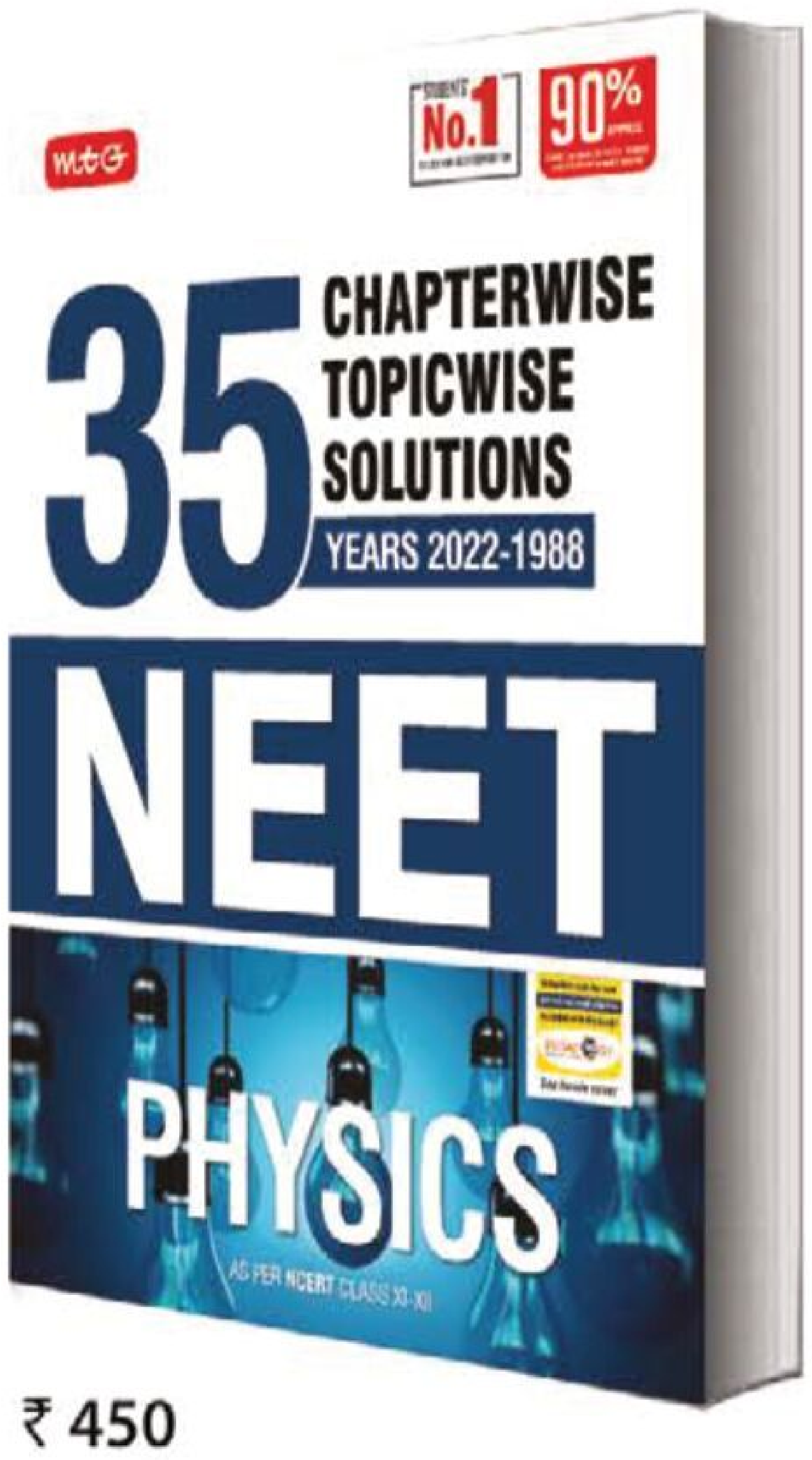
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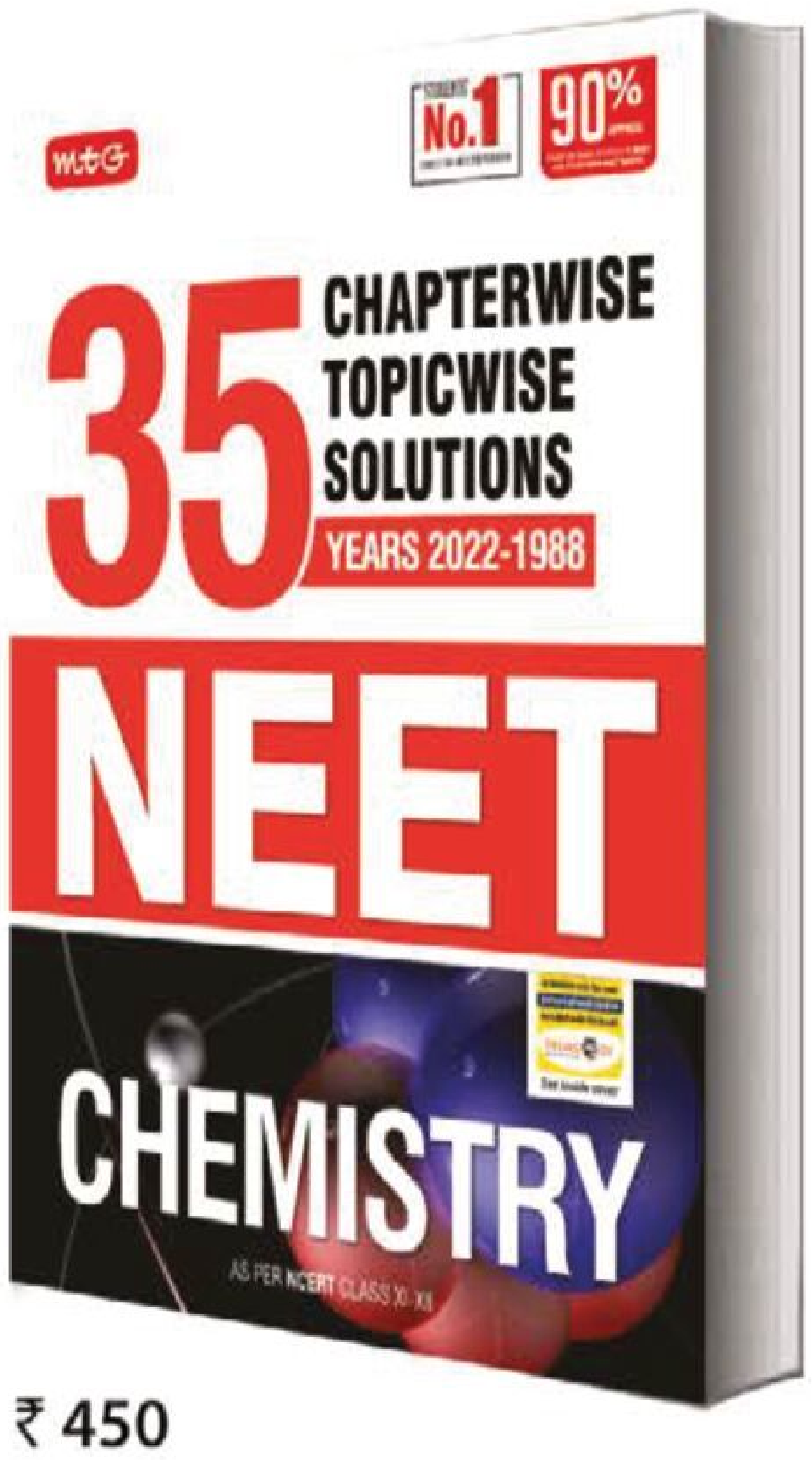
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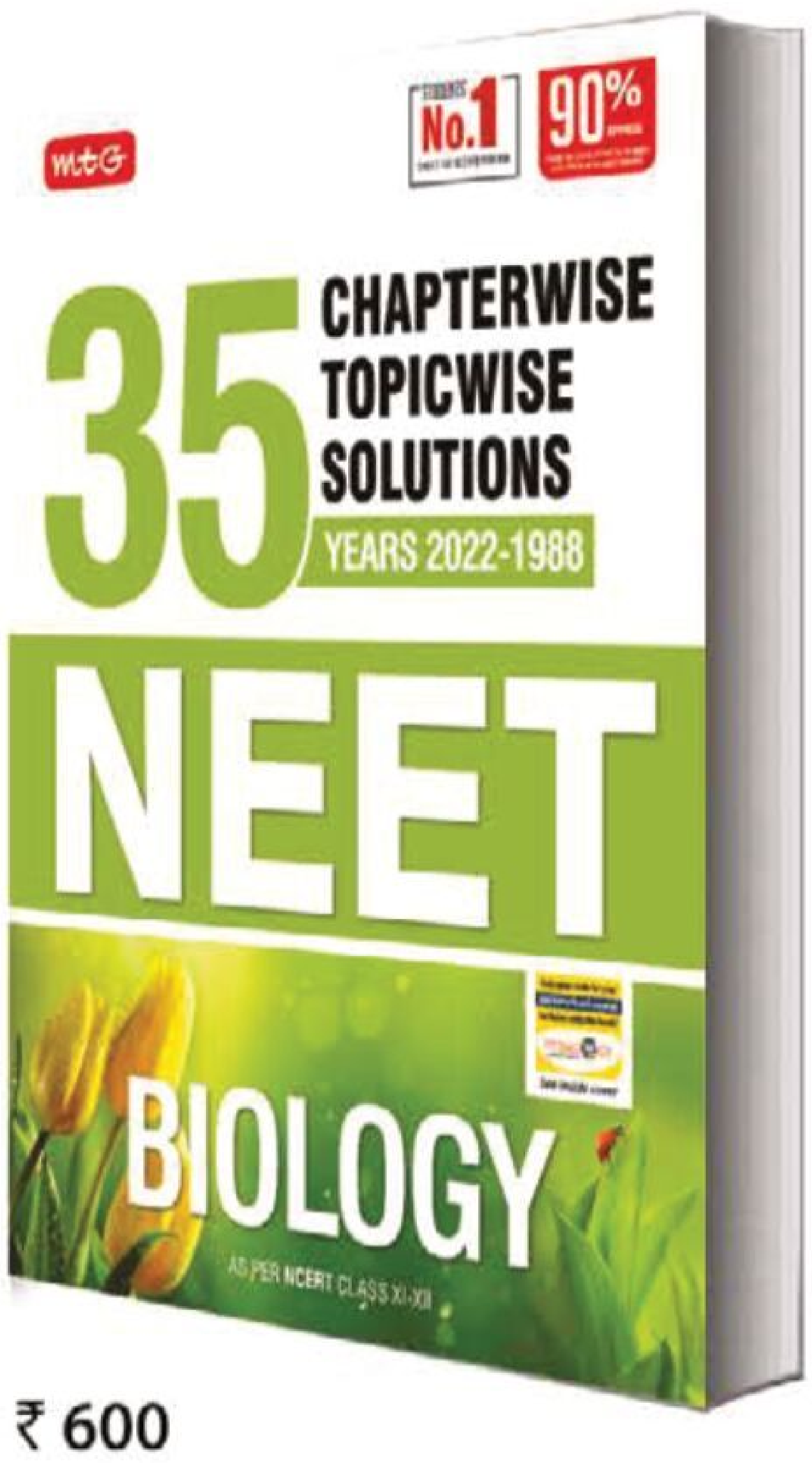
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